ARCTIC TEST CENTER, AMC—
U.S. ARMY, ALASKA

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ARMY RESEARCH AND DEVELOPMENT

November–December 1973

SPEAKING ON . . .

U.S. Army Research and Development Needs

Speaking on behalf of Army Chief of Research and Development LTG John R. Deane Jr., Director of Army Research MG Charles D. Daniel Jr. gave one of the major addresses at the recent 55th meeting of the American Defense Preparedness Association (ADPA), formerly the American Ordnance Association, at Fort Bragg, NC. MG Daniel presented a detailed discussion of Army research and development needs or requirements and how the technology base efforts are planned to support these needs.

MG Charles D. Daniel Jr., wife Ann and son Peter, shown during second-star pinning ceremony Aug. 1, 1973.

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Planners and programers have at least five possible ways to look at Army research and development needs: Combat and support areas; strategic versus tactical; types of conflict; budgetary; and major systems.

The first approach considers needs of combat and support areas, such as Infantry, Field Artillery, or Engineer operations. Although this user-oriented approach has some similarity to the old Technical Services way of doing R&D, the fact that the approach is mission-area oriented means that its scope within each area cuts across a wide variety of technologies. Many requirements these days cut across combat areas and it is difficult to ascribe a need to a specific area.

The next comparison considers strategic versus tactical missions. Our needs from the over-all perspective of the Department of Defense are often considered this way. Since most of the Army's equipment and materiel, except for ballistic missile defense, is tactical, there is little to be gained from this approach.

The third approach is based upon the degree of conflict that we must plan for, whether limited war, cold war, mid-intensity, high-intensity or nuclear war. The nomenclature is overlapping, difficult to quantify and tends to polarize into a limited war versus a nuclear war. During a conflict we are forced by necessity to address the needs of that conflict. Once a conflict is over, developers are freer to look more to the future. The paradox, though, is that resources are then more difficult to justify.

The fourth alternative, along budget lines, is the way we are often forced to consider our R&D needs. Bookkeepers like to compartmentalize our requirements and the problem here is the fragmentation of efforts along budget lines. It is often difficult to see the big picture of support of a technology, component, or weapon system when pieces are spread across research and exploratory, advanced and engineering development.

The last alternative is to concentrate attention on major systems where most of the dollars are. For example, about half of FY 74 Army RDTE funds devoted to tactical systems in advanced and engineering development goes to the Army's so-called "Big 5": Mechanized Infantry Combat Vehicle (MICV); XM-1 Main Battle Tank; Advanced Attack Helicopter (AAH); Utility Tactical Transport Aircraft System (UTTAS); and Surface to Air Missile–Development (SAM-D).

Several management and priority reasons warrant giving major systems their due attention. On the other hand, there is one danger we must be alert to in emphasizing major systems. We usually plan for a military mission and then program for the systems that make up that mission. However, once work begins on the systems, the mission may be pushed to the background.

Advantages and disadvantages apply to each of the five alternatives that have been mentioned. The alternative that is used is often dependent upon the demand or audience for our actions.

The greatest criticism to the whole system of identifying needs and requirements is that somehow the user's perspective gets lost in the current system. As a field artilleryman, I would like to emphasize the first alternative, that of combat and support areas to put my message across. In the process, I will integrate aspects of the other four alternatives into my presentation.

Early this past spring, I asked some people in my Army Research Directorate to take a new look at the over-all budget and identify support of combat areas and auxillary functions. I also asked them to see if weaknesses or major deficiencies could be detected from

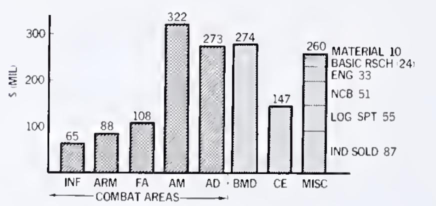

Figure 1

this approach. The Analysis was to include all 6.1 research, 6.2 exploratory development, 6.3 advanced development, and 6.4 engineering development. What we observed for FY 74 is shown in Figure 1.

The left side represents millions of dollars. On the bottom are categories used to sort out the total 6.1 through 6.4 FY 74 budget of about $1.5 billion. Approximately half of the over-all funding is in the first five areas, which I refer to as combat areas: infantry; armor; field artillery; airmobile; and air-defense artillery. Ballistic missile defense, and communications/electronics/intelligence share about one-fourth of the total funding.

The miscellaneous category includes all remaining efforts that could not be assigned to the other seven. About the only basic research in the miscellaneous area is in physics, chemistry, mathematics, and our in-house laboratory director's fund, known as the ILIR (In-House Laboratories Independent Research) Program. From a relevancy viewpoint, it is interesting to observe that about one-fourth our basic research and half our exploratory development for FY 74 contribute to the five combat area applications.

The Big 5 are fairly well dispersed among four of the five combat areas: MICV in infantry; XM-1 in armor; UTTAS and AAH in airmobile forces; and SAM-D in air defense. This makes our program fairly uniformly hardware strong.

INFANTRY

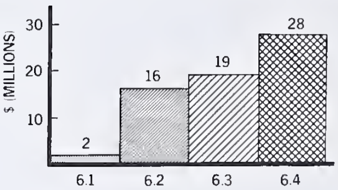

Figure 2

During the remainder of this presentation, I plan to address technology and system needs individually for most of the major categories listed in Figures 1 and 2. The needs that I will mention will tend to address requirements beyond those planned for well-known major systems currently under development or planned for the near future.

The equipment required to support all types of infantry operations is very extensive. Essentially, it cuts across many technology areas, including weapons, communications, vehicles, clothing, aviation, night vision, logistics, and engineer equipment. For this reason, it is difficult to identify R&D that is specific for infantry operations.

The dollar effort identified for infantry in Figure 2 is the lowest of all the combat areas. This should not be interpreted that the infantryman is being short-changed. Rather, many of the things he needs are not as big nor as

(Continued on page 22)

ABOUT THE COVER:

Environmental testing of materiel and equipment required to keep the U.S. Army in a state of combat readiness for any emergency worldwide is a responsibility of the Test and Evaluation Command, headquartered at Aberdeen (MD) Proving Ground. TECOM is a major subordinate element of the U.S. Army Materiel Command with command and control of the Arctic Test Center (ATC) at Fort Greely, AK, where extreme cold weather testing is conducted. The ATC effort is integrated closely with the training mission of the U.S. Army, Alaska, which puts emphasis on mobility where intense cold (record—81 degrees) may turn engine oil in vehicles to "the consistency of chewing gum." Travel by skis or snowshoes thus becomes basic to training.

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Published bimonthly by the Plans and Programs Division of the Research, Development and Engineering Directorate, HQ U.S. Army Materiel Command, Alexandria, VA, in coordination with the Technical and Industrial Liaison Team, Office of the Chief of Research and Development, HQ Department of the Army, to serve all elements of the U.S. Army R&D community.

Grateful acknowledgement is made for the valuable assistance of Information Offices within the Army Materiel Command, Office of the Surgeon General, Office of the Chief of Engineers, Army Training and Doctrine Command, Army Forces Command, Office of the Assistant Chief of Staff for Force Development, Office of the Assistant Chief of Staff for Communications-Electronics, Computer Systems Command, and miscellaneous related activities. Use of funds for printing of this publication has been approved by the Department of the Army, Jan. 1, 1972.

Purpose: To improve informal communication among all segments of the Army scientific community and other Government R&D agencies; to further understanding of Army R&D progress, problem areas and program planning; to stimulate more closely integrated and coordinated effort among Army R&D activities; to express views of leaders, as pertinent to their responsibilities, and to keep personnel informed on matters germane to their welfare and pride of service.

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Submission of Material: All articles submitted for publication must be channeled through the technical liaison or public information officer at installation or command level.

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DISTRIBUTION is based on requirements submitted on DA Form 12-4. Army agency requirements must be mailed to the U.S. Army AG Publications Center, 2800 Eastern Boulevard, Baltimore, MD 21220.

Distribution on an individual name basis is restricted to members of the U.S. Army Atomic Energy and R&D Officer Programs and to R&D Mobilization Designees. Otherwise, distribution is made only to the Army installation, office or organizational element to which the requester is assigned.

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Selective Scanner . . .

Intrusion Detection System Type Classified

Type classification of the Joint Service Interior Intrusion Detection System as Logistic Control Code A (LCCA) was announced late in October by the developing agency, the U.S. Army Mobility Equipment R&D Center, Fort Belvoir, VA.

LCCA classifications means the equipment is the most advanced and satisfactory item available to satisfy current user requirements.

Developed by the Countermine/Counter Intrusion Department, the J-SIIDS is a standardized system for use by the Army, Navy and Air Force, primarily in the protection of arms rooms. It can also be used for applications such as finance offices, post exchanges, communication centers, computer centers, Class VI stores and storage areas for narcotics, accountable property and high dollar items.

The J-SIIDS equipment is of modular design and employs sensors to detect penetration into rooms, movement of intruders, and touch or removal of protected items within the rooms. It enhances the security of any area by providing round-the-clock surveillance without the necessity of a 24-hour guard post or security forces in the immediate area.

An intrusion alarm can be relayed to a nearby security post or used to alert the appropriate command personnel that a breach of security has occurred.

The system is composed of a family of four types of sensors (penetration, motion, point, and duress), a control unit, a monitor unit, a data transmission system and a local audible alarm.

Initial deliveries for testing are scheduled in January 1974.

Picatinny Exceeds FY 1973 VE Savings Goal

Final tabulation of FY 1973 value engineering (VE) savings at Picatinny Arsenal, Dover, NJ, has totaled $16,662,300, more than double the assigned cost-cutting goal of $7,700,000.

Leading contributors to the VE program included the Ammunition Development and Engineering Directorate with $13,740,000; Product Assurance Directorate, $1,835,900; Feltman Research Laboratory with $476,300; Nuclear Development and Engineering Directorate, $453,900; and Industrial Operations Directorate with $114,900.

In addition to FY 1973 savings, the second highest since the program began in 1968, a projected estimate over the next three years of $47,492,600 was announced.

Commenting on the success of this year's VE program, COL Jonathan L. Holman Jr., Picatinny Arsenal commander, said "VE really works when engineers consciously and continuously keep its principles in mind and apply them."

PICATINNY ARSENAL commander, COL Jonathan L. Holman Jr., discusses Dragon launcher signature simulator with Jacob Switinsky. Others who contributed to VE savings through development of missile simulators are (l. to r.) Irwin Spiess, Lawrence Daly, James Long and Gabriel Gratowski.

Boat-Cradle May Ease Ribbon Bridge Launching

Development tests of a prototype boat-cradle designed to transport a bridge-erection boat, launch and retrieve it are being conducted by the U.S. Army Armor and Engineer Board (USARENBD), Fort Knox, KY.

The device is designed to eliminate problems encountered with the method of transporting and launching the 27-foot boat used in erecting the ribbon bridge. Formerly, the boat was transported in two sections on a standard 2½-ton truck and a 4-ton trailer. Launching and retrieval of the boats were difficult and time-consuming tasks, requiring a 20-ton crane to lift and couple the two boat sections for operations.

The boat-cradle was designed and mounted by the U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA, on a modified standard M821 bridge-transporter 5-ton truck with a hydraulic boom for launching and retrieving the boat.

USAENPG Gains 750-Kw Unit Responsibilities

Joint Chiefs of Staff Contingency Mission responsibility for 72-hour deployment of three 750-kw air-transportable power units anywhere in the world is a new function of the U.S. Army Engineer Power Group, Fort Belvoir, VA.

The power output from three such generators would meet the electrical needs of about 225 average homes. Assignment of the new function to the USAENPG is in line with its revision of mission for a fast-growing Non-Tactical Generator (NTG) Program, assumed last spring after the SM-1 nuclear power plant at Belvoir was deactivated.

In effect, the USAENPG has become the Army's "high-power production" agency with an "arsenal" of 10,000 kw of nuclear power combined with 188,800 kw of conventional power spread among 1,500-kw, 750-kw and 500-kw generators, distributed from Thailand to the Panama Canal Zone.

The first class of 14 trainees on the 750-kw units under the JCS Contingency Mission was graduated recently, with LTC William R. Licht, deputy commander and deputy director of the USAENPG, presenting diplomas.

In view of the increasing energy crunch, he said it is conceivable that "Sparky," the JCS deployment team emblem, would make its way around the world.

Movie Describes Clothing/Field Ration Progress

"Progress in Specialized Clothing and Field Rations," a recently issued 27-minute research and development film, depicts Natick Laboratories' progress on behalf of the combat soldier by improvements in food processing and protective clothing.

Displayed are the new freeze-dried, compressed food processes and the new flexible packaging system for thermo-processed foods developed to enable the soldier to take into the field a variety of superior quality, nutritious foods.

Vastly improved protective and special clothing includes helmets, uniforms, footwear, body armor and flame retardant clothing developed to protect the foot soldier, aircraft, and combat vehicle crewmen against a wide range of environmental and climatic threats—flame, thermal and battlefield ballistic dangers, chemical warfare agents and personnel detection devices.

MERDC Achieves Record Cost Reductions

Citing it as the most successful effort of its kind in the center's history, COL T. R. Hukkala, commander, U.S. Army Mobility Equipment R&D Center, Fort Belvoir, VA, recently announced a FY73 Cost Reduction Program saving of $7,886,300.

This saving exceeded by 300 percent the goal established by the U.S. Army Troop Support Command, headquartered at St. Louis, MO. Major achievements were in value engineering and in procurement, supply, and general management improvements.

Development of a synthetic modular, lightweight camouflage screening system accounted for the largest savings of $2,660,000. Substantial savings resulted from improved negotiation techniques and "should cost" studies.

Army Applies SLAR for Geographical Survey

MOHAWK aircraft equipped with Side-Looking Airborne Radar (SLAR), the elongated rectangular box connected to the lower right side of the fuselage, has flown more than 10 missions for the U.S. Army Corps of Engineers and other governmental agencies to better determine possible flood areas, provide pollution and contamination data on the environment, and to collect fire-damage data to aid in protecting and regenerating forests.

U.S. Army aircraft equipped with Side-Looking Airborne Radar (SLAR) are being used in a survey to obtain geographical data valuable to the Canadian government and the U.S. Army Corps of Engineers.

The joint project is expected to yield information to determine the extent of salt pollution of inland waterways near the Canadian border and in the States of Washington and Montana. Data collected also will be used for further mapping of the Fort Peck Dam and Reservoir area near Glascow, MT.

The surveying capabilities of SLAR are being utilized by courtesy of the U.S. Army Electronic Proving Ground (USAEPG) and the Intelligence Center and School (ICS) at Fort Huachuca, AZ.

SLAR and another aerial scanning device known as the Thermal Infrared Scanner (TIRS) have also been used recently to aid the U.S. Army Engineer Topographic Laboratory at Fort Belvoir, VA, and the U.S. Forestry Service. Both instruments have been used on Mohawk aircraft for tactical military operations and training purposes for some time.

The fog-penetrating and special sensory capabilities of SLAR and TIRS were used to survey the extent of damage during the recent 6-state fire that raged through the northwestern section of the country. SLAR also was used recently to survey the Libby Dam areas of Montana and flood damage during cresting of the Missouri and Mississippi Rivers at St. Louis in April 1973.

TIRS assisted in aerial coverage of the West Virginia flood areas and provided data collections over Puget Sound in Washington. SLAR and TIRS were also used in surveys to determine salt pollution of rivers and streams in the Red River Basin area.

SATCOM Assumes Control of Simulation Facility

Transfer of control of a System Simulation Facility (SSF), which enables engineers to simulate operation of a satellite communications system in a laboratory environment, was effected recently from the Defense Communications Agency to the U.S. Army Satellite Communications (SATCOM) Agency, Fort Monmouth, NJ.

Occupying 1,350 square feet of floor space, the facility can simulate operation of an entire satellite communications network, such as the Defense Satellite Communication System.

The SSF permits testing of frequency plans, to determine if they are usable in an actual satellite communications system, as well as the testing of new equipment to determine if it is compatible with existing equipment.

Operable manually or automatically through a computer, it is designed to measure the ratio of signal power to noise in the system, the amount of available satellite power each earth terminal is using, and frequency of operation of all terminals.

The SSF can simulate the AN/MSC-46 transportable earth terminal; up to 21 additional terminals communicating through a single satellite; a jamming station; the movement of the satellite or terminal, or both, to generate the Doppler effect; and the transmission and reception of a number of types of communications, including voice, teletype and data.

Watervliet Awards $1.6 Million for Antipollution

Two contracts totaling $1,626,488 for construction of a new incinerator and control equipment expected to reduce Watervliet Arsenal air pollution to near zero level were announced recently by the New York District, U.S. Army Corps of Engineers.

The new incinerator, which will meet all air quality standards of New York State, will be completed in August 1974, at a cost of $818,488, and will be capable of burning solid wastes and nonsoluble oils. Soluble oils and plating wastes are treated for removal of pollutants in the arsenal's water pollution control plant which became operative in 1970.

The second contract, for $808,000, provides for antipollution equipment and facilities. Abatement devices will be installed to control fumes generated by plating operations. An oil collection system will ensure, by November 1974, that in-building oil spills do not find their way into the Hudson River. Included in this contract is the installation of equipment to remove oil and automatically crush metal turnings and chips resulting from manufacturing. The oil will be incinerated and the chips loaded on railroad cars or trucks.

ECOM Surpasses FY73 Cost Reduction Goal

U.S. Army Electronics Command cost reduction results for FY 73 surpassed predicted goals by 229 percent and included several multimillion dollar improvement actions.

ECOM's cost reduction goal of $21 million was surpassed by actual savings of $48,049,800. Additional 3-year savings of $84,925,600 are forecast through FY73 actions.

Cost reductions attributed to improved procedures saved $16 million, including competitive procurement of the AN/PPS-5 radar set, solid-state device applications, initiation of a temperature-stress program at the AN/ARC-115 radio set manufacturing facility, and redesigned circuit boards.

Five improvement actions accounted for more than half the dollar savings from 126 individual actions registered. Cost reductions generally are made in 12 areas including value engineering and supply, transportation, and traffic management.

Dugway Demonstrates Aircraft Crash Rescue Unit

An impressive demonstration of capabilities of a new P-4 aircraft-crash rescue vehicle, costing $98,000 and representative of a tri-Service coordinated developmental effort, was given recently at Dugway Proving Ground, UT.

Dugway PG, the first Army installation to acquire the unit, showed its capabilities to about 25 Army and Utah local officials. In the past, each of the military services developed its own aircraft-crash rescue vehicles to meet its special requirements. The P-4 and a larger P-2 model have been used at a number of Air Force bases.

During testing, the P-4 logged over 8,000 miles on rough terrain, and in one test controlled a blaze from 2,000 gallons of jet fuel in seven seconds. The P-4 has a water capacity of 1,500 gallons, and pumps at the rate of 1,200 gallons per minute through a 510-horsepower diesel engine also used for locomotion. It also can utilize firefighting foam through twin turrets and hand lines.

The 23-ton (fully loaded) truck is over 10 feet high and 30 feet long, and can accelerate to 60 miles per hour in less than one minute. The P-4 has a stream range of more than 150 feet.

P-4 Crash Truck Demonstration at Dugway Proving Ground

R&D News . . .

APG Tests Air-Supported Roof for Fuel Shelter

Imagine an air-supported shelter large enough to protect two-thirds the area of a football field and you are visualizing a developmental roof now being tested at Aberdeen (MD) Proving Ground to protect the Army's 25,000-barrel bulk fuel storage reservoir.

Engineer design and engineer test phase objectives for the 194-foot-long, 102-foot-wide experimental roof have been consolidated into a phase two development test and evaluation by the Service Support Equipment Branch, General Equipment Division, Materiel Testing Directorate.

Made of lightweight, elastomer-coated fabric, the shelter comes in three sections that are rolled out and secured to each other by interlocking wooden pegs. The 6,000-pound weight of the roof is supported by some 800,000 cubic feet of air generated by a 10,000-cubic-foot-per-minute blower.

Only a very slight overpressure—one inch of water or 1/28th pounds-per-square-inch—is required to support the roof, which is secured to the ground by 72 expandable anchors.

Test directors Robert T. Muse and Richard Britton said that testing at APG will be limited to natural climatic conditions, except that hot- and cold-chamber tests will be conducted on samples of the roof fabric, including prepared seams furnished by the developer, and on one full-sized roof section.

A 25,000-barrel (1.8 million gallons) hasty, bulk-fuel-storage reservoir was not available upon which to install and test the roof. A 4-foot-high berm was constructed to simulate the area required by the reservoir.

During the technical and operational performance evaluations, internal air-pressures, temperatures and relative humidities, as well as external. ambient air-temperatures, atmo-

spheric pressures, relative humidities, wind velocities, wind directions and amounts of precipitation will be recorded.

To collect data on wind velocities and directions, the MTD Meteorological Unit has set up a complete weather recording station at the test site. Reliability of the air-supported shelter will be tested by maintaining it in an operational condition continuously 24 hours daily until 1,074 hours of operation have been completed, in addition to a 72-hour break-in period.

One phase of the safety evaluation will be the check for gasoline-vapor buildup. The adequacy of roof venting to release fuel vapors, which accumulate during transfer operations and storage of reservoir fuels, will be evaluated by measuring fuel-vapor buildup within the inflated roof and the tank. A tank-fabric diffusion rate of 0.05 fluid ounces per square foot per 24 hours will be simulated.

Open evaporation of MOGAS (automotive gas) within the covered area will be used to release fuel vapors during operation at a simulated diffusion rate. The fuel-vapor content will be measured at different elevations inside the air-supported roof and at selected points outside the cover structure at various time intervals to determine when and how much MOGAS-vapor buildup occurs.

ARMCOM Issues First XM204 Howitzer Prototypes

Initial prototypes of the XM204 howitzer, a "soft-recoil" system eliminating almost three-fourths of the recoil force in conventional artillery, are being produced at the Rodman Laboratory, U.S. Army Armament Command (ARMCOM), Rock Island, IL.

XM204 development began at the former Weapons Command in 1968 when funds were allocated for preprototype model production, utilizing a system of recoil reduction patented in the early 1900s. The XM204 is intended to replace the M101A1 howitzer used in World War II and the M102 howitzer produced in the mid-sixties and used in Southeast Asia.

When the XM204 lanyard is pulled to fire the weapon, a nitrogen-gas spring shoves the barrel and breech forward to a predetermined point. The weapon fires and the force of the recoil that would normally be transmitted back to the carriage as a jarring shock is expended in partially overcoming the forward thrust of the gas spring.

This is not a one-for-one tradeoff of opposing forces, because the spring does not generate as much forward thrust as backward thrust of the firing. The reduction in recoil force, however, is enough to make a significant difference in weapon characteristics.

With 70 percent less recoil force, an extensive system of stabilizers is unnecessary. The reduction in recoil force also lowers stress to the point that stakes and spades, used to secure the conventional howitzer to the ground, are not needed. From the time the lanyard is pulled to fire a conventional howitzer until the weapon fires, recoils and returns to a ready-to-fire position, the elapsed time is 2.5 seconds. With the XM204 this time is cut to 1.4 seconds, thereby upgrading the rate of fire.

Math Symposium to Examine Finite Elements Applications

Fourteen invited lectures dealing with mathematical aspects of the use of finite elements in the numerical solution of differential equations will be presented at a symposium, Apr. 1–3, 1974, at the Mathematics Research Center, University of Wisconsin.

Members of the program committee are C. de Boor (chairman), J. Bramble, J. Douglas Jr., J. Nitsche and B. Noble. A detailed program of the symposium and information on registration and accommodations will be available about Feb. 1, 1974.

Requests for the program and all related inquires should be directed to Prof. C. de Boor, Mathematics Research Center, University of Wisconsin-Madison, 610 Walnut St., Madison, WI 53706.

TECOM Device Detects Human Aiming Errors

Prototype development of an "Aiming Error Detector" for use in testing aircraft armament systems has been announced by the U.S. Army Test and Evaluation Command (TECOM), Yuma Proving Ground, AZ.

Designed to separate human factors from hardware performance, the AED is expected to increase firing accuracy on targets. Human error has been a long-standing problem in engineering evaluation of lightweight sighting systems. Previous methods of measuring aiming error have included motion picture cameras mounted on relatively massive sighting systems.

Currently being applied in the evaluation of the Helmet Sight Subsystem on the Improved Cobra Armament System, the detector weighs about one-half pound when mounted on the sight, and is not expected to affect pilot-gunner maneuverability.

Design size and weight limitations necessitate use of a small-diameter lens for limited light-gathering ability. A very intense light at the target is required to provide the detector with adequate visibility at ranges up to several thousand meters, and a strobe light has been designed for this purpose.

Set in an armored bunker near the target, the strobe light is reflected from an expendable mirror. Although the light appears to direct a steady beam, it actually operates at 200 flashes per second at 5-millionths of a second duration.

Undesirable light frequencies from background radiation that may overexpose the sensor are avoided through use of optical filters. Electronic filters separate other interference type signals such as desert ambient light.

Initially, two Aiming Error Dectectors have been built in-house for the current test program. Additional applications may include human engineering studies, involving sighting systems and weapons, training and real-time data processing of cinetheodolite tracking errors.

Credited with conceiving and initiating development of the device is Thorman Ellison of the Aircraft Armament Engineering Branch. Other YPG personnel instrumental in the project include Robert Elmore, electronics engineer, Methodology and Instrumentation Division; Eric Gustafson, electronics technician, Technical Test Support Division, Electronics Section; and Leo Weeks, physical scientist, Methodology and Instrumentation Division.

AIMING ERROR DETECTOR (AED) development team includes (from left, kneeling) Leo Weeks and Robert Elmore. Holding helmets with attached AEDs are Thorman Ellison and Eric Gustafson.

Revised AR 70-45 Alters Scientific, Technical Information Policies

Changes in policy governing the Department of the Army Scientific and Technical Information (S&TI) Program are detailed in a revision to Army Regulation 70–45, to be effective Dec. 1, 1973.

Superseding AR 70–45, Scientific and Technical Information Program, dated Aug. 18, 1965, the revised regulation is being published to meet requirements of the 1973 Army reorganization which separated general staff and operating functions.

The revision states that objectives of the S&TI Program are to improve the flow of technical information into, through and from the Department of the Army (DA).

• To establish a centrally directed and coordinated network of generally decentralized technical information activities managed by major commands and developing agencies.

• To support technical information activities and functions, in general, by improving acquisition, evaluation, storing, processing, announcing, retrieving, and disseminating technical data and information that are "products of, related to, or required for support of Research, Development, Testing and Evaluation (RDTE) activities."

The changes delineate responsibilities for providing funds, manpower, materials and information required for managing and operating technical information activities.

Funding for technical information activities that are part of an assigned RDTE mission or that are directly related to the Department of the Army RDTE mission will be provided through established Department of the Army RDTE program and financial channels.

• Funding for activities in elements of the Department of the Army that do not have an assigned RDTE mission, but that involve technical information, will be from sources normally financing these elements.

• Funding may also be provided from assigned S&TI projects with Army-wide applications to any Army command or developing agency for related S&TI efforts.

Delineated specifically are responsibilities of the Chief of R&D (CRD), HQ DA; heads of major Army commands and developing agencies; and the Army Materiel Command.

CRD is responsible for:

• The Army portion of the DoD S&TI Program, to include coordination with the S&TI Programs of the other military services.

• Insuring that the latest R&D efforts conducted by federal agencies and contractors in Automatic Data Processing (ADP) hardware, software and information technology are applied to Army S&TI requirements.

Heads of major Army commands and developing agencies will:

• Carry out policy and procedures adopted for the Army S&TI Program; provide guidance, supervision and support to subordinate organizations and activities, consistent with DA policies and objectives, to insure maximum exchange of technical information in support of scientific and technical missions.

• Appoint a single point of contact for S&TI for the command or developing agency that will serve in an advisory capacity to the Army S&TI Program.

• Develop and maintain a continuously updated 5-year S&TI Program for the command or developing agency, based on scientific and technical information needs and internal proposals for initiating, revising, or terminating projects of the S&TI Program.

Responsibilities in developing the S&TI programs include:

• The documented, updated, 5-year S&TI Program of the command or developing agency will include copies of DD Form 1634 (RCS DD-DR&E (AR) 925) or AMC Form 1534-R for each project and task, and Project Unfunded Requirements Statements if required.

• The documented 5-year S&TI Program of the command or developing agency will be submitted to the CRD (DARD-ART) for review not later than Feb. 15 of each year (program for the following fiscal year plus four fiscal years).

• Changes to the S&TI program will be submitted to the CRD (DARD-ART) for review at other times during the fiscal year when major changes are proposed.

• All scientific and technical information activities that may require ADP processing services will be coordinated with the management information systems staff of the command or developing agency. Requirements for ADP services, as well as systems and equipment requirements, will be submitted in accordance with AR 18–1 and AR 18–7.

Interface with the Army Data Management Program will insure that applicable data procured under that program can be made available for use by scientists and engineers, as applied under AR 700–51.

Heads of major Army commands and developing agencies will encourage the publication of technical monographs, papers and reports for dissemination of S&TI, in accordance with AR 70–31 and AR 70–14.

Similarly, they will insure that Department of the Army personnel are invited to participate in technical conferences, symposia, colloquia, seminars and other meetings related to their mission areas (see AR 70–26).

The Army Materiel Command (AMC) is additionally assigned responsibility for:

• Planning, programing, managing and operating the scientific and technical subsystem of the Army R&D Information System (ARDIS); also the Research and Technology Work Unit Summary portion of the automated data base, including monitoring timely and accurate submission of DD Form 1498s to the Defense Documentation Center (DDC) by all Army developing agencies.

• Planning, programing, and execution of R&D projects with Army-wide application in areas such as availability and effectiveness of S&TI data; automated storage and retrieval of chemical data and information; indexing and selective dissemination techniques.

• Establishment of operational and data management policies for Army technical libraries, technical information centers, technical information analysis centers, and other document centers that collect, store, retrieve, distribute or otherwise process S&TI.

• Reviewing and consolidating Army requirements for development and operation of S&TI centers supporting RDTE efforts.

• Preparation and publication of Army S&TI Program documentation, including the *Army Research and Development Newsmagazine, Directory of S&TI Holdings and Services, Directory of S&TI Points of Contact,* and the *Army Five-Year S&TI Program* (summary of all Army command and developing agency S&TI programs).

The U.S. Army Research Office (USARO), which was recently reorganized within the Office of the Chief of R&D, with operational functions centered largely at ARO, Durham, NC, is assigned responsibility for:

• Administrative and managerial support for the Army Science Conference, to include assembly and publication of the proceedings.

• Approval and support of Army scientific and technical conferences and symposia.

• Sponsorship and management for Junior Science & Humanities Symposia, and support of high school science & engineering fairs.

The Army Computer Systems Command is responsible for the conduct of software research programs, in coordination with the Chief of R&D, as required to support multi-command ADP systems.

Army Research Office Announces Relocation Plans

Relocation of the U.S. Army Research Office, Durham, NC, an element of the Office of the Chief of Research and Development, HQ DA, from the campus of Duke University to leased facilities in the Durham-Raleigh area, is scheduled by February 1975.

Approval for this action came by a 5 to 2 vote of the Real Estate Subcommittee of the House Armed Services Committee following an Oct. 18 hearing at which an Army Corps of Engineers representative presented facts.

Director of Army Research MG Charles D. Daniel Jr. and Dr. I. R. Hershner, his deputy and scientific director, were present to respond to questions.

The Army Research Office-Durham (ARO-D) was established effective Jan. 16, 1961, as the successor to the Office of Ordnance Research in Durham. With the disestablishment of the Army Research Office, Washington, DC, late in 1972, ARO-D assumed certain of its functions and its acronym, ARO, along with personnel transfers.

Staffed currently with about 100 employes, ARO's mission is to manage that portion of the Army's basic research program relevant to Army interests in mathematics and the physical, engineering, environmental, and life sciences. ARO programs are accomplished through contracts and grants with educational institutions, research organizations, and U.S. Government and industrial laboratories located in the Western Hemisphere.

The relocation is necessitated by the expiration of the lease agreement with Duke University for the present ARO building in February 1975, and the announcement that the university will require this facility for planned expansion. The proposal approved by the Real Estate Subcommittee of the House Armed Services Committee provides for leasing of 22,000 square feet of space, 5,000 less than ARO now occupies.

The presentation to the subcommittee stressed that relocation in the Durham-Raleigh area is considered in the best interests of Army research because of close scientific working relationships with the three major universities in the area—Duke, North Carolina, and North Carolina State—plus an estimated minimal moving cost of $200,000 to an out-of-state area.

R&D NEWS

Army Adapting AN/PPS-15 Lightweight Radar Unit

The AN/PPS-15 lightweight, backpack ground-surveillance radar successfully demonstrated recently at HQ Army Electronics Command, Fort Monmouth, NJ, will undergo Army development and operational tests beginning in January 1974.

The 18-pound, solid-state, 2-channel set can be carried into the field to supplement radars already in operation. It uses a unique frequency-modulated signal processing technique under development since 1964 at ECOM's Combat Surveillance and Target Acquisition Laboratory.

Separate control and antenna units provide for remote operation. While the antenna unit remains on a scanning pedestal and tripod, the control display unit enables the operator to use the radar from a foxhole or other protected place. Target information is given by both audible and visual means. Moving targets can be detected to ranges of 3,000 meters under limited or no visibility conditions.

Through an ECOM contract, the Marine Corps has ordered 428 production units of the new radar set, built by General Dynamics Electronics Division.

Portable Radar Developed For Explosives Detection

"Demonstrated excellent potential in field tests" is reported for a new portable radar mine detector, especially plastic mines, developed under contract for the U.S. Army, but also said to be capable of "looking down" through several feet of concrete and soil to serve many civilian needs.

Plastic mines, inexpensive to manufacture and difficult to detect reliably with the equipment available in the Southeast Asia conflict, caused many casualties, leading to expedited action to improve detection methods.

The new radar detector, developed for the U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, VA, is envisioned by Calspan Corp. (formerly Cornell Aeronautical Laboratory, Inc.) as having potential for such civilian community requirements as locating water, sewer and gas lines, and human bodies buried in debris or landslides.

Anthony V. Alongi, staff scientist and Radar Mine Detection Program manager for Calspan Corp., explains:

"The nature of the return radar signal distinguishes these substances from each other and from such natural subsurface formations as rocks and boulders. It measures their size and depth below the surface within a few inches, thus telling precisely where and how to dig."

The technology developed under the MERDC contract is being used by Calspan to investigate possible applications to civilian requirements for accurately locating underground conduits and other objects. Preliminary results, Alongi said, have demonstrated a capability of locating lines, either metal or plastic pipes and conduits.

"This is particularly valuable," he continued, "in reducing digging at busy street intersections, where the lines may have been buried at varied times over a period of many years, and not always in the locations where the old city maps say they are supposed to go.

"Concrete is, in effect, transparent for the radar. We have traced plastic pipes through and behind concrete walls. Looking down through a concrete highway, you can pick up the tie rods beneath; also, any voids in the subsurface caused by the underside of the concrete leaching away or hidden water undermining part of the roadway's foundation."

In view of numerous catastrophic gas line explosions attributed by investigators to construction excavation work that has resulted in seepage of gas into homes and apartment buildings, this detection capability is of special concern.

Detection is explained by the fact that every discontinuity in the soil—even a change from one density to another, or wet to dry—is accompanied by a change in electrical properties. As the radar signal penetrates the soil, part of its energy is "bounced back" in telltale fashion from each such change. Characteristics relate to the reflecting source.

In qualifying capabilities of the device, as firmly established in testing to date, Alongi explained that military versions are intended primarily for objects buried no deeper than in minefields. Future equipment, in his view, could make tradeoffs, in the very precise resolution attained to date, to permit penetration to "many feet for civilian projects."

In association with the Army, Calspan has also developed a one-man version of the radar system weighing less than 20 pounds. Straps over the operator's shoulders support a 10-foot-long horizontal boom. Batteries and the transmitter are in a balancing box at the back end of the boom. A video signal is visible on the screen of a small oscilloscope on the operator's chest. An audio signal is relayed through headphones.

Envisioned by Alongi is a version of the radar with multiple antenna horns carried on a vehicle that "could easily be built to monitor the subsurface conditions on major highways—while cruising at 60 mph to guide routine maintenance or survey entire highway systems for hidden weakened spots in areas where major flooding has occurred."

PORTABLE RADAR, developed to detect mines and other subsurface explosives, is being tested to locate buried objects such as utility conduits, human bodies.

APG Tests Front-Load Forklift For Shipping Container Transfer

Feasibility tests of a front-loading forklift truck capable of a 25-ton lift are being conducted by the Materiel Testing Directorate, Aberdeen Proving Ground (APG), MD, to fill a requirement for a self-propelled vehicle to load and transfer large shipping containers.

Fitted with a 17-foot collapsible lifting mast, the 110,000-pound vehicle is an articulated, 4-wheel, rough-terrain tractor powered by a 325-hp diesel engine. It has a single-lever, power-shift transmission with three speeds forward and three in reverse.

Toplift attachments can handle 40-foot and 20-foot commercial International Organization for Standardization (ISO) containers as well as 20-foot MILVAN containers. Six-foot auxiliary forks enable it to handle small containers such as Air Force pallets and break-bulk cargo. Designed and developed by Caterpillar Co., its commercial designation is rubber-tired tractor No. 824.

Logistics-Over-The-Shore (LOTS) tests will be conducted at Fort Story, VA, to evaluate the capability of the forklift to be transported by marine vessels and landing craft, and to be discharged as cargo from ship to shore.

Following the LOTS phase of testing, the forklift truck will be tested at the U.S. Navy's Little Creek Amphibious Base, VA, by the U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA. The vehicle will then be returned to APG to complete the feasibility tests.

Synthetic Fur Replaces Natural Type for Army Use

Testing and evaluation of synthetic fur developed for military use in extreme cold weather garments, conducted by the U.S. Army Arctic Test Center at three locations in Alaska over a 6-month period, has climaxed in a decision to discontinue use of natural fur for U.S. Army needs.

Evaluation of results of the test program at Fort Greely, Fort Wainwright and Nome, Alaska, is detailed in a recently issued final report on Project No. 8-EI-485-000-040 of the U.S. Army Test and Evaluation Command. The title is "Product Improvement Test of Hood, Extreme Cold Weather Under Arctic Winter Conditions."

Seventy-two hoods with three different types of synthetic fur ruffs (30 dyed, treated; 30 dyed, untreated; 12 undyed, untreated) were provided for the test. The evaluation compared their qualities to 60 standard U.S. Army hoods with natural fur ruffs for control purposes.

Over-all evaluation findings are that synthetic modacrylic fiber fur, undyed and untreated, proved superior to dyed and treated synthetic fur, and is "equal to or better than," in protective and most other qualities, the natural fur currently used in U.S. Army parka ruffs.

All three types of synthetic fur test ruffs were less flammable than the standard natural fur ruffs. Both synthetic and natural fur ruffs burned in flames. However, the natural fur continued to burn after the flame was removed and the synthetic fur was "self-extinguishing."

The synthetic fur was made of knitted pile cloth with 60 percent of modacrylic fiber guard hairs and 40 percent ground hairs of polyester fibers interlaced in the fabric.

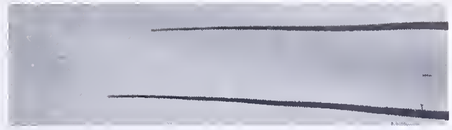
"From a human factors viewpoint," the test report states, "the test items are considered safe to wear since there were no reported cases of frostbite or dermatological problems experienced during field testing. . . . No damage or deterioration resulted from laundering the test hoods and they were as easily maintained as the standard hood."

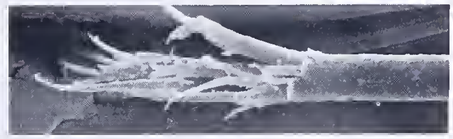
Synthetic fur research has been conducted rather sporadically at the U.S. Army Natick (MA) Laboratories for about a decade, with the degree of interest varying in accordance with changing requirement attitudes.

Conservationists' complaints, in the form of hundreds of letters to Congress, the Office of the Chief of Research and Development, HQ U.S. Army Materiel Command and various other Army agencies in 1971–72, brought about one of these changes in attitudes.

The letters contended that the wolverine—the best source of supply for the high quality of fur needed by the U.S. Army for protective garments against extreme cold weather—was becoming scarce, along with wolves, the second best source.

In response to numerous inquiries from members of Congress and the public clamor of the ecologists, the U.S. Army effort to develop an acceptable synthetic fur was intensified. Within a short time the earlier research helped to return dividends in improvements that led to the 1972–73 test program at the three Alaskan installations.





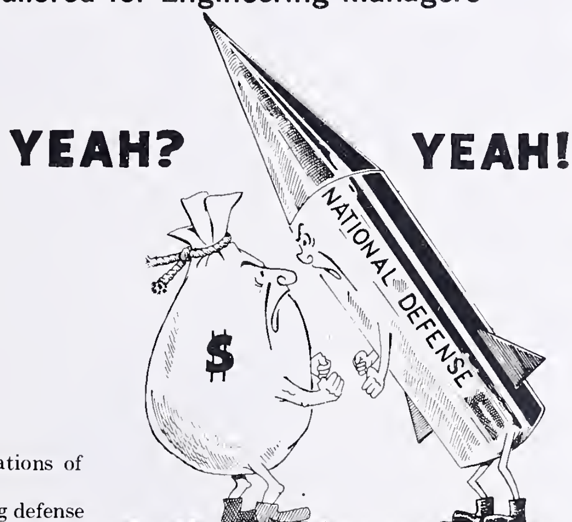
Natural Fur (500X). This fiber has been damaged from handling and has broken down into cortical cells.

Qualities of natural fur were studied closely under microscopes in comparison with various types of synthetic fur. Among the findings was that the natural fur has a "rather scale-like surface" and that the hairs taper gradually to a point at their extremity of exposure to the weather. Theoretically, this characteristic makes wolverine and wolf fur less susceptible to frost accumulation in parka ruffs, and consequently to matting, which reduces thermal efficiency.

Results of such studies, however, is of relatively small importance to the conservationists. Much more of interest to them is that synthetic fur has been developed to eliminate the Army's requirement for natural fur.

Cost Estimating Course Tailored for Engineering Managers

Who is interested in cost? The cartoon shown here may depict congressional concern about defense expenditures. Until recently, R&D managers have often found it expedient to allow cost to grow while striving to meet schedule and performance goals.



In view of the double-barreled impact on shrinking funding and manpower resources, however, the Department of Defense no longer can consider cost second to either performance or schedule requirements. The philosophies of design to unit production cost, operational effectiveness analysis, and trading off performance for cost are some indications of current emphasis.

Cost is used as a tool for controlling defense expenditures. It is also used as a criterion for decision-making. The choice between alternate systems or alternate approaches to problem resolution is influenced by the cost of the alternatives. The least costly satisfactory solution is generally selected. The result of an inaccurate estimate of cost may be an erroneous decision.

The engineering manager is inextricably involved in this decision process. To be effective, he must be knowledgeable of the uses of cost estimates and the methodology used in developing these estimates.

The U.S. Army Logistics Management Center (USALMC) offers Cost Estimating for Engineers (CEE), a 2-week course designed to assist the engineering manager in understanding and working with estimates of cost. Instructors qualified by technical background and experience in R&D activities and project management offices throughout the Army Materiel Command (AMC) present instruction on estimating techniques applied to real problems drawn from AMC experience. Advantages and disadvantages are explored in depth.

FY 74 course offerings at the USALMC begin Oct. 29, 1973, Feb. 25, 1974, and May 6, 1974.

Applicants should be graduates of accredited engineering colleges or hold engineering titles or job descriptions. For further information or enrollment instructions, contact the USALMC registrar on Autovon 687-2197 or the course director on Autovon 687-2027.

LIGHTWEIGHT COMPANY LEVEL 60mm mortar being developed to replace the 81mm medium mortar in infantry, airmobile and airborne rifle companies excited considerable interest at the recent 4th Army Mortar Program (ARMOP) Conference at Watervliet (NY) Arsenal. Examining it are (l. to r.) Lawrence Harmon, arsenal engineer who coordinated the conference, and chairman LTC Thomas Bryan, Office of the Assistant Chief of Staff for Force Development, HQ DA, with Paul K. Rummel, director of Engineering and Development at Watervliet. Seventy mortar specialists from Army agencies and U.S. Marine Corps elements representing developers, trainers and users attended the conference. ARMOP was formed in 1971 to establish a systematic and coordinated effort for the improvement and development of infantry indirect-fire support weapons.

Relief for the Infantryman . . .
New Back-Pack Promises Greater Adaptability

Improved comfort and load-carrying adaptability are designed into a new back-pack system that will begin to be phased into the inventory for infantrymen in 1974 to alleviate one of the foot soldier's oldest problems—how to carry a wide variety of combat gear, simply and with less sweat and strain.

Developed by the U.S. Army Natick (MA) Laboratories, the M-1972 load-carrying system can accommodate combat needs from field rations to heavy ammunition and containers. Different loads can be carried by simple adaptation of the four main components.

Adopted by the Army and Marine Corps, the system's interchangeable components are combat-load suspenders and belt, an intrenching-tool carrier, small arms ammunition cases, a medium or large field-pack to hold the existence load for everyday needs, existence-load shoulder straps that permit quick jettison of the load, and a frame with an optional cargo-support shelf for heavy or bulky items such as ammunition containers, ration boxes or electronic equipment.

Separation of the combat load and the existence load, by means of a quick-release pull-tab on the shoulder straps, is another new feature. Previously, the existence load was permanently attached to the combat-load suspenders. The medium field-pack is for routine operations and the large pack for extended missions or cold-weather areas.

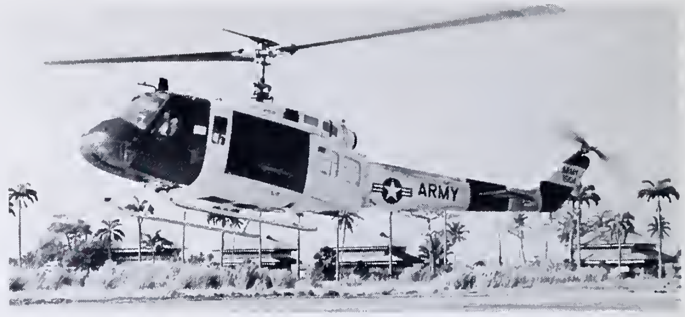
Safety features of the M-1972 system include small pockets and fastener straps for grenades that previously were just hooked onto webbing. The streamlined pack-frame has no side projections that can get caught in the brush. Strong lightweight materials, such as aluminum tubing for the pack-frame and water-repellent nylon for packs, straps and belt, add to the system's durability.

The shoulder straps have thicker padding and greater width than before and are curved in front to fit body contours. New types of adjusters allow the infantryman to adjust his equipment more easily for fit, even while marching.

Besides supporting and distributing load-weight, the pack-frame rests on the back in a way that prevents direct contact with the lower back and thus lessens heat buildup by allowing ventilation.

The M-1972 load-carrying equipment was extensively tested on acceleration (shake) tests at the Natick Laboratories, as well as in climatic chambers and actual field tests. Results confirmed the system's superiority in all respects to equipment now in service.

R&D NEWS



UH-1D helicopter hovers over a helipad laid down by the Universal Liquid Distributor for dust control at Randolph, CZ. This test is being conducted by the U.S. Army Tropic Test Center, Fort Clayton, CZ, to evaluate performance of dust control materials under "wet-warm" and "wet-hot" conditions.

Salvage Nets $1.7 Million for USACC Project

Salvage of communications-electronics equipment from Vietnam will contribute to saving about $1.7 million of an estimated cost of $6 million to install a communications system for the Armed Forces of the Philippines (AFP).

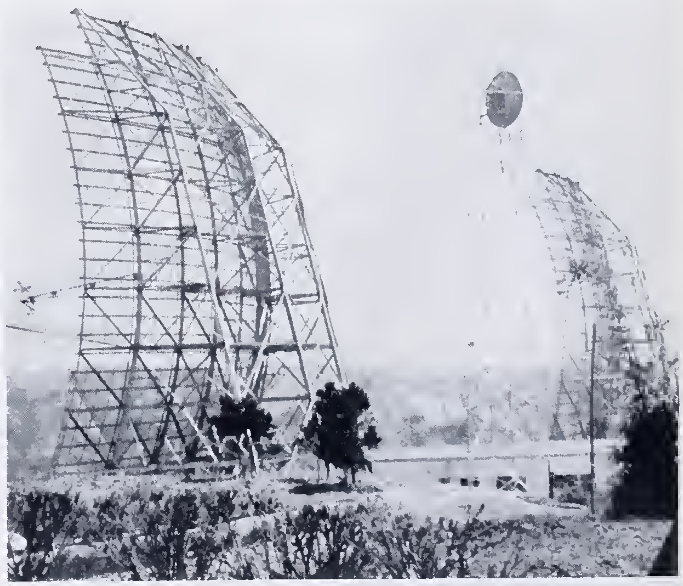
Developed by the U.S. Army Communications Command (USACC), the combination microwave/tropospheric-scatter network will span over 500 miles of land and ocean when completed in 1974. Design of the U.S. military-aid project will permit future expansion from 60 to 120 channels.

BG D. W. Ogden Jr., commander of the U.S. Army Communications System Agency (CSA) and the Communications Electronics Engineering Installation Agency (CEEIA), explained that part of the $1.7 million saving is due to the fact that "American-trained Filipino personnel are installing the system on their own, with minimal assistance from our CEEIA-Western Hemisphere organization."

The first phase of the system was completed in December 1971 with a troposcatter link from Tagaytay City on Luzon to Mt. Luay, Cebu Island, some 325 miles to the south. This system interfaces with 60-channel microwave links to communications centers at Fort Bonifacio, near Manila, Luzon, and Camp Lapu Lapu, Cebu.

Under the present phase of the project, the CEEIA Field Office-Philippines is coordinating the construction efforts of the AFP and USACC's CSA and CEEIA at two sites on Mindanao, one of the Republic's southernmost islands.

Two Mindanao Island sites are located at Camp Evangelista, Cagayan de Oro, and HQ Southwest Command, Zamboanga. When completed they will be linked to the Mt. Luay relay site, some 200 miles to the north, to complete a command and control communications system from Manila to the southern tip of the island republic.



TROPOSPHERIC-SCATTER communications system on Mt. Luay speeds messages over 300 miles in Hawaiian network.

Army Holds Atmospheric Sciences Military Theme Review at NCAR

Fourteen selected atmospheric sciences projects were reviewed recently during a Chief Investigators' Conference and Review of Military Themes at the National Center for Atmospheric Research (NCAR), Boulder, CO.

Sponsored by the U.S. Army Research Office (ARO), Durham, NC, the Military Theme Program provides a vehicle for identifying research to be accomplished that will contribute to solution of critical Army problems. Formal review procedures assure that the unsolicited basic research proposals supported are of high scientific merit and are relevant to military requirements.

Military Themes are defined as "descriptions of critical Army problems in applied research or exploratory development where progress has been inhibited by a lack of understanding of fundamentals or a scarcity of basic data coupled with suggested areas for basic research designed to provide the data and knowledge required for the resolution of the problem."

Fifty military themes are centered currently on problem areas that require basic research contributions, primarily in the environmental sciences, chemistry, engineering, mathematics, metallurgy and ceramics, and physics. Problem areas in the Life Sciences will be added when the revised edition of the Military Themes brochure is published soon.

Review meetings are designed to encourage communications between Army scientists, chief investigators supported through ARO research grants and contracts, and the scientific community.

The scientific sessions started with "Highlights of the NCAR Programs," a review by Dr. David Atlas of NCAR of seven representative projects conducted by NCAR scientists; a "Review of the NOAA Atmospheric Physics and Chemistry Laboratory Programs" in weather modification by NCAR Director Dr. Helmut Weickmann; and a "Review of the Wave Propagation Laboratory Remote Sensing Program by Dr. Gordon Little, director.

A "Review of the Army Research Office-Europe Atmospheric Research Program" was presented by Dr. Hoyt Lemons, chief of the Environmental Sciences Division, ARO-Europe. Other Army scientists' presentations included:

Some Consequences of the Inherent Error Structure of Active and Passive Balloon Tracking Devices, Dr. Walter B. Miller, Atmospheric Sciences Laboratory, White Sands (NM) Missile Range (WSMR); Problems in the Parameterization of Radiosonde Data, A Practical Viewpoint, Dr. O. M. Essenwanger, U.S. Army Missile Command; and

Combined Stratospheric Measuring Program, Dr. Franklin E. Niles, Army Ballistic Research Laboratories, Aberdeen (MD) Proving Ground; Stratospheric Thermal Structure and Composition, Dr. H. N. Ballard, WSMR; and Solar Radiative Transfer in Clouds Using Eddington's Approximation, CPT Robert J. Junk Jr., Deseret (UT) Test Center.

Chief Investigators' presentations included: Numerical Procedures for Analyzing and Predicting Mesoscale Tropical Weather Patterns, R. L. Mancuso, Stanford Research Laboratory; Climatic Modeling, Dr. W. D. Sellers, University of Arizona; Theoretical

(Continued on page 23)

The National Center for Atmospheric Research (NCAR) is a national laboratory sponsored by the National Science Foundation and operated by the University Corporation for Atmospheric Research (UCAR), a nonprofit group of 39 U.S. and Canadian universities.

The missions and major efforts currently being conducted by NCAR were covered in a feature story, "NCAR Keys on Hail, Global Atmosphere Study," in the Boulder Daily Camera, *Sept. 11, 1973. Information extracted from tnat report follows.*

The work of the staff of more than 600 NCAR scientists and engineers is conducted by specialists in such fields as computer science, research aviation, scientific ballooning, and field observation techniques including radar meteorology.

NCAR's primary missions are to support the university atmospheric sciences community, and to carry out research in the national interest that requires large, coordinated efforts difficult to organize and perform in a single university.

Two current efforts of major importance to NCAR are the National Hail Research Experiment (NHRE) and the Global Atmospheric Research Program (GARP).

The NHRE is a 5-year field program developed to gain an understanding of the physics and dynamics of hailstorms; also, to test the feasibility of using cloud seeding as a means to reduce damaging hail that causes millions of dollars damage annually to crops in the United States. The NHRE research is centered on an experimental area along the Colorado-Nebraska state line, in the middle of "Hail Alley," the region that has more hailstorms than any other part of the United States. Weather radar, research aircraft, radiosondes, a network of instruments on the ground, and other tools of atmospheric research are used to study both seeded and unseeded hailstorms.

The GARP is an international effort aimed at increasing the understanding of the global behavior of the atmosphere. One goal is to extend the range of accurate, weather prediction from the present one or two days to two weeks or more. NCAR is involved in GARP in a number of ways, including global circulation models to simulate atmospheric behavior using the high-speed electronic computer facilities at NCAR.

NCAR scientists have participated in planning for the first major GARP field program, which will be conducted in the tropical Atlantic Ocean off the west coast of Africa next summer. NCAR aircraft will participate in this experiment, and a new wind measuring device developed by NCAR will be used.

NCAR's interest in the atmosphere extends beyond our own planet. During 1973, scientists at NCAR's High Altitude Observatory (HAO) made valuable new observations of the solar corona—the atmosphere of the sun.

A solar telescope designed and built at HAO was sent into space aboard the Skylab orbiting laboratory. Astronauts on the first mission brought back about 4,400 photographs of the solar corona which reportedly show a great deal of fine detail in the corona, and document changes that could not be observed by any other means.

HDL Improves Short-Intrusion Fuze Capability

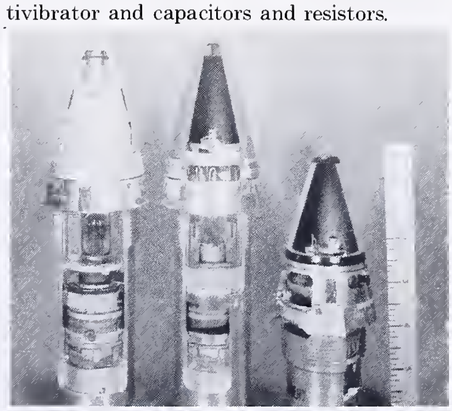
Product improvement engineering for the first artillery proximity fuze, having the same intrusion as that of point-detonating and mechanical-time fuzes, has been completed by the U.S. Army Materiel Command Harry Diamond Laboratories, Washington, DC.

This short-intrusion fuze (SIF) will replace all previous proximity fuzes for HE (high explosive) field artillery shells. HDL fuze experts say it will eliminate the need for deep-cavity shells and their supplementary charges, with cost savings estimated at $0.70 per shell. Another benefit will be that of the restriction on firing the older proximity fuzes at charge 7 in the 105mm howitzer will not apply to the new fuze.

The SIF incorporates a new electronic-arming timer that will eliminate the need for precision mechanical clocks of the type used in previous artillery proximity fuzes such as the M513 for small-caliber shells (75 to 105mm) and the M514 fuze for large-caliber shells (155mm to 8-in.). Both fuzes had a settable delay and were produced for the Navy between 1953 and 1957.

The current M514A1E1 artillery proximity fuze was designed by HDL in 1967 and has been produced sine 1969. Major components of the M514A1E1 were the same as used in its predecessors; however, a new antenna and semiconductor components, together with a simplified power supply, replaced vacuum tube technology. The design allowed the use of one fuze type, independent of the size shell and independent of the angle of fall of the shell. The final production type of this fuze was designated M728.

The SIF introduces the next generation of artillery proximity fuzes and is the result of a product improvement program that began in 1970, with an intent of reducing the intrusion into the shell. Electrically similar to the M728, it incorporates an electronic analogue timer consisting of an integrated circuit multivibrator and capacitors and resistors.



PROXIMITY FUZES for artillery-caliber shells (from left) include the first fuze developed by the Navy during the Korean Era, HDL's product-improved fuze, and the latest, which uses integrated circuits.

8 Major Problems Considered at 22d NDT Conference

Technical presentations on eight major problem areas and 28 papers describing ongoing research, development, test and evaluation activities featured the 22d Defense Conference on Nondestructive Testing in Houston, TX, Nov. 13–15.

Topics of all the problem areas and technical papers, abstracts and the authors were listed in a special edition of the *Nondestructive Testing Newsletter*. Edited by Charles P. Merhib and published by the Nondestructive Testing Information Analysis Center (NTIAC), U.S. Army Materials and Mechanics Research Center, Watertown, MA, the newsletter was issued prior to the conference.

Problems presented include: NDT of Cast Explosives, W. F. Larsen, M. H. Weinberg, Picatinny Arsenal, Dover, NJ; Nondestructive Examination of the PM-3A Nuclear Power Plant Reactor Pressure Vessel for Chloride Stress Corrosion Cracking, LCDR J. L. Renzetti, Fort Belvoir, VA; and

Inspection of the Horizontal Stabilizer Power Control Cylinder Assembly on A-7 Aircraft for Safe-Service Life-Extension, F. W. Thomas, Naval Air Station (NAS), Jacksonville, FL; Instrumental Determination of Tendons, Cartilage, Ligaments, and Fascia in Ground Meat by NDT, C. W. R. Wade, U.S. Army Medical Bioengineering R&D Laboratory, Fort Detrick, MD; and

Coating Thickness and Continuity of Nonmetallic Cartridge Cases, A. Nativo, Picatinny; Wear Shoes on Eddy Current Probes, R. Ehnes, Charleston Air Force Base (AFB), SC; Nondestructive Inspection of Welds in Biazial Shock Test Machine, A. Kumar, U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL; and Lensatic Compass Vial Problems, R. Zimmer, U.S. Army Troop Support Command (TROSCOM), St. Louis, MO.

Papers presented include: Initial Feasibility Study Employing Holographic Vibrational Analysis to Locate Non-Bonds in Thick Ceramic to Fiberglass Composite, M. J. Barbarisi, B. R. Chisholm, Picatinny; Application of Acoustic Emission to Weld Monitoring, Dr. A. Kumar, CERL; and

An Infrared Analysis of M113 Solid-Rubber Road Wheels, D. K. Wilburn, U.S. Army Tank-Automotive Command (TACOM), Warren, MI; Holographic NDT of Sandwich-Type Material, M. L. Budnick, U.S. Army Natick Laboratories, Natick, MA; and

Recent Developments in the Determination of Material Integrity by Acoustic Analysis, B. Hoffman, M. Mondress, Frankford Arsenal, Philadelphia, PA; Establishment of a Tentative Ultrasonic Cleanliness Standard, D. V. Moberg, Rock Island Arsenal (RIA), Rock Island, IL; and

Detection of Landing Gear Pin Grinding Damage, L. R. Gulley Jr., Wright-Patterson AFB, OH; Magnetic Rubber Inspections of Fuel-Flow Holes in AFFDL/FBT Fatigue Test Wing, J. F. Taylor, Wright-Patterson AFB; The Application of Ultrasonic Techniques for Leak Detection of Aircraft Systems, A. J. Koury, Naval Air Systems Command, Washington, DC, J. Erthal, R. K. Munger, M. J. Devine, Naval Air Development Center, Warminster, PA; and

A Novel, Analytical Method for Selecting Ultrasonic Transducers for the Inspection of Tubular Shapes, H. Hartmann, Picatinny; Ultrasonic C-Scan for Inspection of Brazed Rotating Bands on an Artillery Shell, J. S. Pasman, Picatinny; Feasibility Study of an Automatic Photo-Crack Detection System for Performing Magnetic-Particle Inspection of XM42 Shells, E. G. Kessler, P. Kisatsky, Picatinny; and

Ultrasonic Examination of Ceramic Insulators, H. L. Hime, Washington Navy Yard, Washington, DC; NDT and Residual Stress Reduction in Aircraft Aluminum Forgings, J. F. Collins, R. A. Day, C. E. Maduell, NAS, Alameda, CA; Radiological Safety in NDT, G. W. Hendrix, Naval Nuclear Power Unit, Radiological Affairs Support Office, Fort Belvoir; and

Operational-Level NDI Application, D. E. Gross, Travis AFB, CA; Nondestructive Airfield Pavement Evaluation, J. D. Walters, H. A. Balakrishna Rao, Air Force Weapons Laboratory, Kirtland AFB, NM; Testing the Surface Quality of Optical Components, H. E. Bennett, M. J. Soileau, Naval Weapons Center, China Lake, CA, and G. J. Hutcheson, U.S. Army Missile Command (MICOM), Redstone Arsenal, AL; and

Is That River Loose? An Ultrasonic Technique May Supply Some of the Answers, R. Bailey, Warner Robins AFB, GA; Instrumentation Requirements for Acoustic Emission, W. H. Schoeller, Picatinny; Semiautomatic Crack Measurement and Recording, D. C. Winters, Benet Weapons Laboratory, Watervliet, NY; and

Safety Problems Associated With the Use of Ionizing Radiation in the Inspection of Material, H. V. Piltingsrud, USAF Radiological Health Laboratory, Wright-Patterson AFB; Ultrasonic Holography in NDT Applications, P. C. McEleney, AMMRC; Detection of Exfoliation of F-106 Air Intake Duct, J. A. Petru, Kelly AFB, TX; and

Computer-Aided Optical Techniques for Flaw and Void Detection in Composite Solid Propellant Motor Cases, J. Griffin, MICOM; Automatic Gamma Scan Analysis of Large Rocket Motors, E. M. Bergh, Naval Weapons Station, Concord, CA; Nondestructive Inspection of Cracked G76032 MLG Axle Piston Assemblies, E. F. Nicosia, Naval Air Rework Facility, Pensacola, FL; and Foreign NDT Techniques, Equipment and Application, J. Mounter, L. G. Klinken, U.S. Army Foreign Science and Technology Center, Charlottesville, VA.

R&D NEWS

Flat-Surface Canopy Decreases Aircraft Sunlight Reflections

Reduction of canopy sun reflections from the Army's Attack Helicopter is the objective of a test configuration of a flat-surfaced canopy in a quick reaction program approach devised by the U.S. Army Land Warfare Laboratory, Aberdeen (MD) Proving Ground.

The immediate problem was that sun reflections from the canopy call attention to the helicopter, beyond normal viewing distances. The LWL canopy was designed to show that reflection could be directed away from enemy observers and into a "safe" zone immediately below or above the helicopter.

Flight tests consisting of a side-by-side comparison with a standard helicopter were made under various sun conditions. The resultant decrease in sun reflections was dramatic, demonstrating that flat surfaces could be used to advantage in the development of a canopy having few, if any, reflections to serve as the initial source of discovery.

The test aircraft is also being modified to reduce rotor blade reflections and will again be subjected to test at Aberdeen Proving Ground. Jerry Cook, Applied Physics Branch, is the task officer.

FLAT-SURFACED CANOPY on the Army's AH-1G Attack Helicopter (left) was designed and built by the U.S. Army Land Warfare Laboratory to reduce sun reflections that can be seen beyond normal viewing distances. Standard canopy is at right.

Evasive Target Tank Adds Realism to Field Tests

Realism in field and operational tests involving antitank guided missiles has been increased significantly by the U.S. Army Materiel Command's development of the Evasive Target Tank (ETT).

The U.S. Army Human Engineering Laboratory (HEL) was responsible for over-all project coordination, design and modification of the ETT. The Materiel Test Directorate of Aberdeen Proving Ground and the U.S. Army Test and Evaluation Command also participated in design, modification and safety certification of the vehicle.

The ETT was developed initially for use in the Combat Development Command Experimentation Command's Experiment 11.8, which is the field testing portion of Defense Project TETAM (Tactical Effectiveness Testing of Antitank Guided Missiles).

The Evasive Target Tank was designed and fabricated around the basic M48A3 combat tank and utilizes a 2-man crew—a driver and a vehicle commander. The standard M48A3 lightweight turret is cut at about 15 inches above the turret ring. The roof is 1½-inch armor plate ballistically welded to the turret.

The final turret configuration was achieved by fabricating a fiberglass shell and simulated 105mm gun to resemble the profile of a Soviet T-62 tank. Crew visibility is provided by specially designed safety-vision blocks and a closed-circuit television system.

In addition to providing a realistic manned, maneuvering target, the ETT affords the maximum degree of safety to the crew when the tank is hit by inert warhead antitank missiles. Protection for the M48A3 chassis includes metal skirts along the sides of the vehicle, metal plates positioned to protect intake and exhaust ports, and additional armor plates around the turret ring—all designed to facilitate ease of maintenance and constructed to prevent interference with normal operation of the vehicle's power plant.

Evasive Target Tank

Additional safety features to insure crew safety include fire detection/extinguishing systems, radio communications and distress signal flares, two escape hatches which can be opened from either side, and a ballistic blanket lining in the crew compartment.

The Evasive Target Tank has completed its participation in TETAM and has been further modified for use in TOW/Cobra Operational Test II at the U.S. Army Armor Center, Fort Knox, KY. During the TOW/Cobra test the ETT will be subjected to inert warhead TOW missiles fired from a Cobra helicopter in flight.

While many individuals participated in the successful design and employment of the ETT, much of the credit has been attributed to the HEL project officer, Nonnie F. Dickinson Jr. and the outstanding soldiers who manned the tank: SGT David C. Forties, SSG Jack C. Stoddard, SSG Clifton C. Beachum Jr., and SP4 Paul N. Veach.

Reduced Aircraft Weapon Radiation Levels Sought

Radiation levels of hot aircraft weapons that may enable enemy heat-seeking missiles to "lock on" and destroy them are being studied in phase two of a research program at the Rodman Laboratory, U.S. Army Armament Command (ARMCOM).

Phase one lasted nine months and was concerned with determining the target area and extent of infrared emission from the hot weapons during combat firing schedules. combat conditions.

A portable infrared viewing device took 35mm black and white prints of various weapons as they were fired during three weeks of phase one testing at Camp McCoy, WI. Mapping was accomplished by use of thermocouples attached to low-temperature portions of the weapons. A remote infrared device developed at the Rodman Lab was used for higher temperature parts and rotating gun barrels.

To simulate firing conditions that exist during flight, a low-speed, nonrecirculating wind tunnel was constructed at Camp McCoy. Air speeds up to 90 knots were developed in the wind tunnel during firing so the simulation of gun-cooling could be evaluated under actual conditions. A 450-hp aircraft engine, similar to those used on the Army's Beaver aircraft, powered the wind tunnel.

Radiation levels of hot aircraft weapons were not always the prime source of "locking-on" a moving target. Previously, in simulation tests, the engines on Army helicopters were the prime source of infrared radiation.

WIND TUNNEL, simulating firing conditions during aircraft flight, was used to study infrared radiation from hot weapons.

Work conducted during the past year at the U.S. Army Mobility Research and Development Laboratory, Fort Eustis, VA, has resulted in reduction of infrared levels of turbine exhaust plumes that make hot aircraft weapons susceptible to "locking-on" by enemy heat-seeking missiles.

Newsmagazine 'Tries Harder' Despite Spacial Reductions

Understandably, quite a few of the *Army Research and Development Newsmagazine's* most valued and vital human resources—the information officers and their staffs at all levels of our area of responsibility, along with bylined feature article authors—are becoming somewhat frustrated.

For example, one of our cherished friends recently put it this way: "The boss is beating me about the head and shoulders because . . . our coverage tailed off to nothing in your July-August edition . . . I know that your cut from 52 to 36 pages makes it very difficult if not impossible to give all of your contributors the coverage they think they deserve . . . Also, your magazine has been very generous with space allotted to (our) activities. . . ."

That complaint pinpoints the problem of the Newsmagazine editorial staff. Reduction from a monthly to a bimonthly edition, and from 52 to 36 pages—as directed by the Ad Hoc Authorization Committee on Periodicals, following the big flap in certain news media about the "Pentagon Publications Empire"—makes it impossible to serve the total R&D community as we would like to do. In effect, we have about one-third the space we formerly had for that task.

Necessarily, after a brief "flirtation" period of using larger headlines, more white space to set off articles for eye appeal, and larger reader type for accommodation of some of our elderly readers who have had to accept bifocals as a less than desirable fact of life, we are back to where we started 13 years ago. Our headlines and reader type are smaller, pictures minimal in size, makeup tight—all in an effort to give coverage to as broad a variety of news as possible.

Consequently, to our "lifelines" in the field, please have patience. The times are austere—tough on nearly everyone. All we can say is, keep the really good R&D information pouring in to us. We will try to give space to as many R&D activities, as varied and broad a representation of the major scientific disciplinary areas, as is feasible.

Hopefully, optimistically, better days are coming. In the meantime, from the collective hearts of the editorial staff, our deep appreciation to our "maintenance friends."

QUOTE: "One side effect of technology is that corporate executives tend to substitute the language of machinery for the language of human beings. . . . Almost without realizing it, managers start describing human actions in nonhuman terms. Employes are urged to 'interface,' to discuss the 'parameters' of a new assignment, to recognize how the secretarial shortage has increased 'by an order of magnitude.' Members of a committee . . . provide 'input' within a given 'time frame.'

"One could say that the introduction of these technological terms into everyday situations represents the corruption of language. But that is not the point. The corporation is at heart a collection of people, and people do not work the same way as machines. The use of these terms tends to dehumanize the corporation at a time when it is being accused of being mechanical in responses to problems. . . .

"Words are, indeed, slippery. But those executives who speak for the corporation—both internally and externally—should choose their words with care. The fact is that when people come together, they may talk, listen, discuss, declaim, shout, pontificate, exhort, persuade, cuss and agree. But they *never* interface."—Burson-Marsteller, Public Relations.

TEMPS . . .

Simulates Nuclear Blasts for Weapons Electromagnetic Survivability Analyses

Deer grazing near Woodbridge, VA, last March scarcely noticed the strange-looking device with which they shared pasturage. Even the brief, metallic ping sounding as the sole evidence of activity from the device failed to disturb their foraging.

The device was TEMPS (Transportable Electromagnetic Pulse Simulator), which looked like a giant double-ended flashlight suspended by wires from four 120-foot poles, the focal point of an antenna system 984 feet long.

Neither the deer herd nor the birds which used TEMPS as an occasional roost sensed danger during test demonstrations, even though the device, releasing up to 7 million volts of electrical energy in pulses, was simulating the awesome disruption of natural forces caused by a nuclear blast.

TEMPS, developed by the Harry Diamond Laboratories, U.S. Army Materiel Command, under sponsorship of the Defense Nuclear Agency, is termed a "threat-level" simulator. It is designed to create, for test purposes, the realism of electromagnetic pulse (EMP), an effect of a nuclear explosion.

The electromagnetic field it produces is similar to that around a lightning bolt but lasting for a much shorter time-span—less than a millionth of a second. Operation of TEMPS at night causes the pulsor to glow for an instant like St. Elmo's Fire. Even this did not disturb the deer.

During operation, a pulse of energy flows from the conical end-pieces of the cylindrical generator. The pulse travels the antenna and is resistively terminated to ground. A transient electromagnetic field, or radio wave, is created around the simulator. This field is used to test the survivability of electronic equipment which might be exposed to the EMP generated by a nuclear weapon burst outside the earth's atmosphere. EMP induces voltage and current surges in unprotected circuitry that can cause logic failure and permanent damage to communications and other electronic equipment.

Department of Defense concern with the threat of EMP to electrical and electronic equipment originated in the mid-1950s. In 1957, during Operation PLUMBOB at the Nevada Test Site, Harry Diamond Laboratories researchers were the first to measure the close-in EMP field successfully.

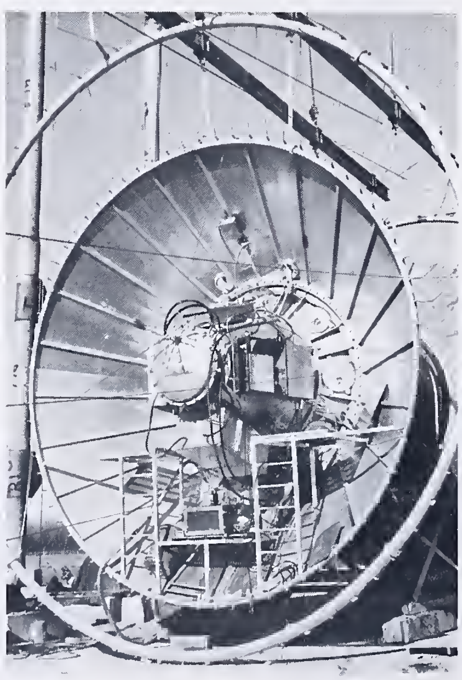
Since then, considerable effort has been directed to protection of critical defense electronic and electrical equipment from disruption of the sort that tripped circuit breakers and damaged components during nuclear tests.

The collision of gamma rays released by the detonation of a nuclear device with air molecules or other materials is the phenomenon producing EMP. The collision separates electrons from air molecules, causing them to move rapidly away from the center of the explosion and from the now positively charged parent molecules. This separation of charges and asymmetries, caused by several factors, creates an intense electromagnetic field, some of which is radiated away.

In a nuclear burst on the surface of the earth, gamma rays are significantly weakened within a few hundred meters of the burst by the density of air at sea level. During a burst outside the atmosphere, however, gamma radiation propagates without attenuation to a deposition region approximately 12 to 25 miles above the earth's surface. The resulting Compton current can extend 2,000 miles and attain a thickness of 10 to 15 miles.

TEMPS 7,000,000-volt pulse generator (right background) is elevated 65 feet above ground and connected to an antenna arrangement (left background). The generator can radiate electromagnetic waves over 150 feet. The control panels are installed inside the van.

Calculations indicate that a nuclear explosion above the atmosphere can generate an intense EMP over hundreds of thousands of square miles, whereas the effective range of surface-burst EMP is relatively restricted. Thus, in the event of nuclear war, the U.S. could be ringed with bursts above the atmosphere and intended by the enemy to disrupt our defense electronics.



PULSER bicone/dipole antenna array is the primary means of launching the high-frequency TEMPS electromagnetic wave.

The same situation could occur with the interception of hostile missiles by our own missile defenses. In either case, far-reaching effects of high-altitude bursts could expose the entire heartland of the nation to potentially damaging EMP. Consequently, programs to "harden" critical equipment to EMP and other nuclear effects have had high priority in national defense development efforts.

The treaty banning atmospheric nuclear tests, however, forced the development of simulation techniques in researching the means to protect vital defense equipment from the effects of EMP. Threat-relatable EMP had to be simulated for use in evaluating the survivability of such equipment. Data gained during the last series of atmospheric nuclear tests, along with computerized analyses, provided descriptions of the environments to be simulated.

Until TEMPS became available, however, technology did not provide a suitable threat-related radiation field of sufficient volume to test a communications facility.

Predecessor simulators to TEMPS took widely differing shapes. Some used wire loops inside which equipment to be tested was placed. Others employ copper coils and large plates to launch the wave. The evolution of designs led to small, transportable pulsers, one version looking like an aluminum streetlight pole dangling from a helicopter. Still others were large stationary simulators with antennae hanging between poles in a configuration like that of TEMPS, except for the absence of a centralized pulser.

In the late 1960s, the Defense Nuclear Agency recognized the need for a transportable EMP simulator to be used in testing fixed systems such as telephone switching centers. At about the same time, the Electromagnetic Effects Laboratory, then under the Army Mobility Equipment Research and Development Center and now under the Harry Diamond Laboratories, conceived the idea of a threat-level simulator that could accommo-

date a system as large as a building 100 feet long and several stories high.

Harry Diamond Laboratories scientists decided that the system should be commercially transportable by truck trailers over standard country-grade roads. They also determined that it would include a pulser, antenna, support structures, four channels of recording instrumentation, data reduction gear, and support gear designed with the expectation of relocating as frequently as four times a year.

Large technical challenges awaited the developers of TEMPS. Time and funds were limited. Problems only partially defined remained to be solved. Staffing the project was the first problem to be overcome because of the need for stringent standards for the qualification of personnel with requisite expertise. This last difficulty was solved by use of both Army in-house laboratory personnel and contractors.

Development of the pulser, however, provided the greatest challenge. Never before had there been a requirement for the release of such great power from portable equipment. With approximately 60 kilojoules of energy stored and 7 megavolts released across the output switch, dielectric insulation materials failed during initial prototype pulser tests. Explosive flashthroughs, corona (gas ionization), and lost energy resulted.

A critical delay in the program occurred when, after performing well, a carefully designed and fabricated peaking capacitor proved unfeasible for manufacture in quantity. TEMPS uses 16 such capacitors. Redesign and testing of a production-oriented capacitor proved successful.

Flashover and electrostatic design problems were solved by using a "clean room" assembly process. The final version survived a 110-percent load during a 5,000-cycle life test.

Major component fabrication and design was accomplished by Physics International Co. of San Leandro, CA, under Harry Diamond Laboratories technical direction. PI personnel joined the completed, assembled pulser to its antenna and first successfully tested TEMPS at Camp Parks near San Leandro late last year.

"Rarely has so large a system, pushing the state-of-the-art, performed so closely to specifications during the first complete test," a project engineer observed.

During the operation of TEMPS, twin Marx generators charged to opposite voltage potential are discharged across a single adjustable switch gap to produce the test pulse. Each generator consists of a column of 35 capacitors charged in parallel and discharged in series.

This system multiplies the voltage of each capacitor by their total number, provides high-frequency content to the pulse, and overcomes inductance in the generators during high-speed discharge.

Generator voltages as high as 3.5 megavolts are impressed across the peaking capacitors in the instant prior to closure of the pulser's output switch. Series addition of the voltages in each column and the opposition of column polarities causes a difference of potential of about 7 million volts developed across the output switch gap.

Triggering is done by electrically switching the terminals of the capacitors, causing them to "erect" and discharge in series. The initial arc ionizes sulphur hexafluoride held under

TEMPS Peaking Capacitors

pressure in a chamber surrounding the switch. The gas is a good insulator until it becomes ionized; then it becomes a good conductor.

TEMPS is designed to produce a double exponential output pulse with less than 10 percent undershoot. The voltage of the pulse rises dramatically to its peak in about 10 nanoseconds (billionths of a second). Then it tapers off relatively slowly, dipping below zero voltage at the first crossover in approximately 800 nanoseconds.

Pulse generator output is radiated by a bicone/dipole antenna array. Two bicone sections, connected across the output switch, are the primary means of launching the high-frequency component of the electromagnetic wave.

Low-frequency radiation is launched by the tapering dipole section, which consists of multi-wired elements extending horizontally from the cones and resistively terminated to ground.

The pulser is controlled and the various functions monitored from an operations van located nearby. Information and commands initiated at a control panel are transmitted to the pulser by pneumatic lines. All connections with the pulser and all supports must be nonconductors. Various safety precaution interlocks are incorporated in case a halt in the firing sequence is required.

Data gathering and processing equipment is housed in a radio-frequency-shielded van linked with target area sensors to test system response and field strengths. Sensors are connected with the instrumentation by a multiplexed signal transmitted over a dielectric waveguide designed to eliminate EMP interference with the data signal.

Instrumentation, consisting of oscilloscopes fitted with polaroid cameras used to record data simultaneously over a variety of sweep and sensitivity settings, includes an automatic system for field mapping.

A digitizer is used to input the shape of curves captured by film from the faces of the oscilloscopes into a minicomputer. Oscillograms thus reduced to many pairs of coordinates are analyzed and key parameters, such as peak amplitude and pulse duration, are recorded for correlation with other data.

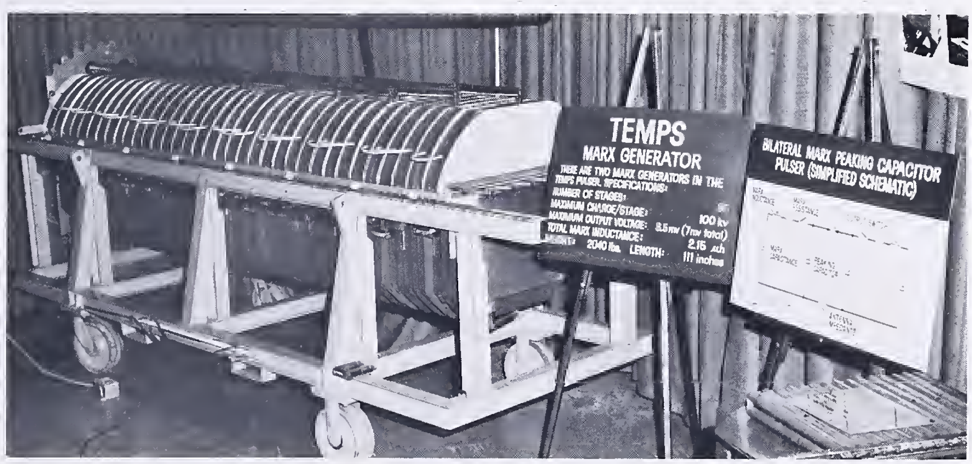
A 5-year program of TEMPS testing of communications facilities began in April 1973 when the facility was set up at Polk City, FL, at an Automatic Voice Network Switching Center which provides government-leased telephone service. Diagnostic data are being accumulated for use in efforts to assure the survivability of similar installations.

When the Polk City tests are completed, TEMPS will be relocated primarily to test facilities under the jurisdiction of the Defense Communications Agency. Other DoD agencies, in coordination with the Defense Nuclear Agency, may subject selected types of military hardware to TEMPS field tests in separate experiments.

TEMPS is one of a family of nuclear effects simulators operated by the Harry Diamond Laboratories as the Army's lead laboratory for nuclear weapons effects. HDL operates other facilities to test military equipment for survivability against the radiation, thermal, blast and shock effects of the nuclear environment.

The AURORA Research Facility, featured in the March-April 1972 issue of *Army Research and Development Newsmagazine*, provides an intense gamma ray pulse. HDL's Hi Flash X-ray Facility can produce either a pulsed electron beam or an X-ray field for the study of transient effects of radiation on various materials, individual components, and even small complete electronic packages.

The Diamond Ordnance Radiation Facility (DORF), operational since January 1962, is one of three U.S. pulse reactors capable of producing neutrons for material-activation analysis and radiation-effects studies.



TEMPS Marx generator is displayed in a shipping container

Challenges Ahead . . .

19th Annual AUSA Meeting Considers Army of the 1970s

Challenges facing the "new profile" Army of the 1970s and responses in meeting them dominated major speeches and panel discussions at the 19th annual meeting of the Association of the United States Army (AUSA), Oct. 15–17, in Washington, DC.

Secretary of State and Nobel Peace Prize recipient Henry A. Kissinger was honored with presentation of the George Catlett Marshall Medal, highest AUSA award, at the climactic memorial dinner.

The award is made to an individual for "selfless and outstanding service to the United States of America." Dr. Kissinger, the 14th recipient of the medal, was cited specifically for his efforts "to effect the peace agreement in Vietnam."

Previous recipients of the award have included last year's winner, entertainer Bob Hope, former Secretary of State Dean Rusk, former Ambassador Henry Cabot Lodge, former Secretary of the Army Cyrus R. Vance, and former Presidents Truman and Eisenhower.

Keynote speaker Secretary of the Army Howard H. Callaway addressed the question of meeting the need for an Army with a volunteer force. He stressed that the challenge facing the U.S. is to make the volunteer Army work.

Expressing his optimism about the results of the volunteer Army thus far, he commented: "It is working because there are still young men and women in America who want to serve their country—this is 'an idea whose time remains' for all Americans, young and old, of every race, color, and creed."

Secretary Callaway stressed that the most important way we are making the volunteer Army work is by insuring that service to the country is a meaningful part of a young man or woman's life. "We are putting a great emphasis on education and training and insuring that our soldiers' jobs are important and useful."

Responding to criticism that Army discipline has declined as the result of hiring civilian KPs, he said, "The Army's mission is not to peel potatoes; its mission is to fight."

Summarizing the benefits and opportunities available in the Army, he noted that there is something in it which appeals to everyone in America—"I count on this appeal to give us an Army which mirrors America. It's not going to be a mercenary Army; it's going to be an all-American Army.

"Even our strongest critics have recognized that one vital element necessary for the success of the volunteer Army lies byond the Army itself," Secretary Callaway said. "I'm talking about public support. Together we can meet the challenges and prove worthy of the nation's trust."

Army Chief of Staff GEN Creighton W. Abrams, AUSA luncheon speaker, discussed today's Army in terms of how it fits into the world picture. He initially addressed misconceptions in defining the word detente, stating:

"The environment today is a difficult one for the country's security. The word detente, which for some people evidently colors everything rose and turns their perceptions away from obvious threats, has gained some currency."

GEN Abrams noted that "detente means only that the tension between countries in the world may in some way have decreased. This is a matter of quality and degree." He stressed the necessity of dealing in facts when addressing the nation's security.

Referring to the mission of the Army, he said: "Insuring that the Army is prepared is my most fundamental duty and is the Army's primary mission at all times . . . If the Army is to be prepared to meet the challenges it faces, it must consider not only the spirit of possible detente, but also the very real capabilities of potential enemies."

Featured speakers at the sustaining members luncheon were Deputy Secretary of Defense William P. Clements, who delivered the keynote address, and AUSA President Edward C. Logelin, presiding toastmaster.

Clements discussed U.S. military strength and the challenges it faces abroad. Touching on the modern Army, he said that utilizing volunteers rather than draftees for our armed forces is an important ingredient for a strong and ready military.

Delivering the annual "President's Report," Logelin commented that "the biggest single problem in the defense area that confronts us today is the lack of understanding of our need for a strong defense."

Logelin emphasized that the second serious challenge facing the Army is that of attracting volunteers of the quality and quantity required. He said that AUSA members "must combat the growing pressure that would reduce seriously our military forces overseas."

Army Chief of Research and Development LTG John R. Deane Jr., speaking at the corporate members reception and luncheon, said that despite the end of the Vietnam War—"The national policy and the will of Congress is to continue to support defense research and development. . . .

"But there is a corollary to this support of defense R&D. . . . The problem is reducing defense costs—and the highest single item is

XV-15 V/STOL tilt-rotor research aircraft. The Bell Helicopter Co. will design, manufacture and test two prototypes in a program sponsored by the Army and NASA.

GEN Creighton W. Abrams
Army Chief of Staff

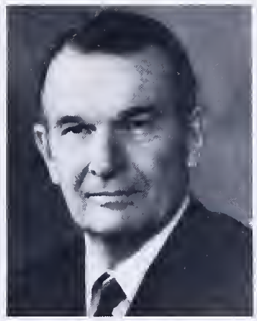
GEN William E. DePuy
TRADOC Commander

LTG W. W. Vaughan
AMC Deputy Commander

LTG John R. Deane Jr.
Army Chief of R&D

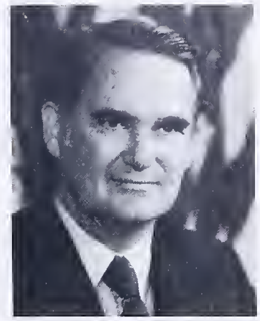
LTG Donn R. Pepke
FORSCOM Deputy Commander

Henry A. Kissinger
Secretary of State



William P. Clements
Deputy SecDef

Howard H. Callaway
Secretary of the Army



Edward C. Logelin
AUSA President

manpower—yet maintaining a credible size force, credible in terms of members in the cutting edge."

LTG Deane noted that there will continue to be "gotta-have," high cost R&D programs. He categorized the "Big Five" materiel development systems, consisting of the Main Battle Tank, Mechanized Infantry Combat Vehicle, UTTAS (Utility Tactical Transport Aircraft System), Advanced Attack Helicopter and the SAM-D air defense system.

Referring to the Big Five, he said: "If we concern ourselves with systems that are basic to the Army's mission, then we should reap the benefit throughout the entire structure."

Other featured speakers included GEN William E. DePuy, commander, Training and Doctrine Command; LTG Donn R. Pepke, deputy commander, Forces Command; and LTG Woodrow W. Vaughan, deputy commander, Army Materiel Command.

More than 50,000 square feet of floor space accommodated about 70 Army exhibits and numerous other industrial presentations, ranging from laser technology applications to fluidics devices.

Exhibition attractions included progress reports on aircraft weaponry such as the Advanced Attack Helicopter, with its emphasis on antiarmor capabilities, the Utility Tactical Transport Aircraft System, and the XV-15 V/STOL tilt-rotor research aircraft.

The XV-15 V/STOL is a jointly sponsored NASA/Army project which combines both helicopter and conventional airplane technology. Features of the system will include a high payload lift capability and relatively low fuel consumption.

Adhering to tradition, the AUSA issued six position papers. Four of these dealt with national security issues—"Our National Interests Overseas," "How Much Defense Do We Need," "Manpower for Defense," and "The Army's Reserve Components."

"Why Do We Need An Army?" explains the role of the Army and its necessity in our national defense. "Military Compensation: Pay Benefits and Retirement" advocates support of the proposed nondisability retirement program.

The two highest awards the AUSA gives annually to individual members were also presented. Ernest L. Massei Jr. of Fayetteville, NC, received the Anthony J. Drexel Biddle Medal for exceptional services to the AUSA. Dr. Lee Sherman Dreyfus, president of Wisconsin State University, was honored with the President's Medal for five years of service on the Army Advisory Panel on ROTC affairs, including three years as its chairman.

Equipment Test Facility Focuses on Infantryman's Needs

By MAJ Wallace B. Eberhard

Will a new sling for the M16A1 rifle hamper an infantryman when he's climbing an obstacle? Will a modified entrenching tool restrict him when he's ready to throw a grenade?

The U.S. Army Infantry Board's Clothing and Equipment Test Facility (CETF), established recently at Fort Benning, GA, will help provide answers to these and many other questions. CETF promises to provide more objective assessments of new and modified clothing and equipment under examination by the USAIB in its testing mission as part of the U.S. Army Test and Evaluation Command.

Sensitivity testing is planned through the summer, and a full schedule of tests using CETF probably will begin in the fall. Infantrymen chosen to negotiate it in developmental tests will have to run, climb, jump, fire, throw grenades, dig entrenchments and perform other tasks considered essential to combat success—and most likely to be affected by their clothing and the equipment carried.

A normal test day will involve up to six hours of running the course. Movements of soldiers will be monitored and measured by a variety of electronic pressure pads and photocells connected to a computer that will record and analyze performance.

Divided into seven subcourses, covering 560 acres, the CETF simulates many of the crucial activities of an infantryman under stress conditions in combat.

A survey of combat infantrymen from World War II, Korea and Vietnam produced a list of the tasks considered basic to success in combat. CETF examines a soldier as he does five of these: maneuvering, marching and moving, using grenades, constructing fighting positions, and firing and reloading weapons.

The maneuver subcourse includes four 5-yard dashes, a zig-zag run, rope bridge, embarkation net, window obstacle, scaling wall, horizontal ladder, long jump, low crawl, log mound and a footbridge.

Progress through this and the other subcourses is controlled by a system of signs and buzzers as cues for moving from one portion to the next. Sensors at the beginning and end of each portion record performance.

Observer/recorders stationed at key points along CETF aid in data input and test supervision.

The march/move hilly track is an unimproved path divided into two half-mile segments for measurement purposes. The march/move flat track is 2½ miles long, divided into half-mile segments.

The grenade emplacement course measures the effects of clothing and equipment on the soldier's ability to throw grenades at a simulated machinegun emplacement from distances of 25 to 35 meters. His time to prepare and throw as well as his throwing accuracy are measured.

At the grenade window course, the infantryman must throw hand grenades against a window/bunker target from six different sites.

In the hasty fighting position, the soldier prepares his entrenching tool for use and shovels a predetermined amount of sand (from 400 pounds upward) into a hopper. His time to complete the shoveling task is measured.

The quick-fire course measures the capabilities of man/weapon systems using quick-reaction firing techniques. As a soldier walks along a 400-meter foot trail through woods, targets pop up at ranges of 60 or 80 meters, while small arms simulators provide an audio cue for him.

The sensor recording system, linked to a computer van, includes microphones, hit-sensitive silhouette targets, miss-distance instrumentation, and small-arms simulators. The range-control data-acquisition system records all these events on magnetic tape and a number of measures can be extracted: time to first round, time to first hit, number of hits, time to shift fire, etc.

The heart of the range control and data acquisition is a Hewlett-Packard 2116A digital computer in a centrally located administrative area. Computer output provides a variety of summary data and statistical analysis of the soldier's performance on any one or all of the tasks on the seven subcourses.

Up to 12 soldiers may be tested on the CETF at one time and they normally are drawn from TO&E units at Fort Benning. A physical conditioning period for test participants is written into each test plan.

Refined methods and instruments for use in CETF testing are being developed by the Methodology and Operations Division of the Infantry Board. A contract was awarded recently to ORA-Operations Research Associates to conduct a Field Equipment Test Methodology investigation. This will focus on improvement of both qualitative and quantitative measures used by the board in testing items of clothing and equipment worn or carried by the individual soldier.

TECOM's Arctic Test Center Integrates Effort . . .

Linked to USARAL Training Mission, Emphasizing Far North Mobility

How to cope universally with adverse environmental conditions by application of advanced technology is now in the public eye as essential to growth and well-being, but in meeting its global combat readiness needs the U.S. Army is a pioneering leader in the field.

Responsibility for assuring that U.S. Army communications and weapons systems, ground mobility vehicles, aircraft, protective clothing, general equipment and other combat materiel will do the job they are designed to do, in all types of environment, with built-in reliability and maintainability, is a responsibility of TECOM.

TECOM is the acronym for the Test and Evaluation Command, whose worldwide mission is accomplished through 14 test centers. Three are situated to subject all test items to the most gruelling of extreme environments. The stressful situations are well calculated to create "the moment of truth" for all systems and the men who operate them.

Nowhere, however, are the adverse environmental factors more ruggedly demanding of men and their instruments of combat readiness, the determinative nitty-gritty of man-machine compatibility in extreme conditions, than at the U.S. Army Arctic Test Center.

Isolated Fort Greely is the home of the ATC, located between the Brooks Mountain Range on the north and the Alaska Range on the south, at the junction of the Alaska and Richardson Highways, about 105 miles southeast of Fairbanks and 335 miles northeast of Anchorage. The ATC is a 659,772-acre testing ground, a Class II activity of the U.S. Army Materiel Command, with TECOM accountable for command and control.

Mother Nature can be beautifully beguiling or vicariously vicious in the Fort Greely area—very suddenly. Thermometer readings in the 80s are quite common during the summer; winter temperatures can hold at 40 below for three or more weeks at a time, and frequently may be much colder.

The Bolio Lake Test Site, for example, is a particularly deceptive sight, a thing of wondrous wild beauty in the summer in its setting of mountains and coniferous trees less than 180 miles below the Arctic Circle. Lake Bolio, at its best, offers something for everyone—anglers, hunters, trappers, boatsmen, hikers and picnickers.

When the winter test season sets in, Lake Bolio is really something else—in fact, its record low of 81 below zero is second only in world history to a minus 90-degrees in Siberia. The 60-man test team at Lake Bolio, linked to HQ ATC by telephone and a 9-mile stretch of snowy, windswept road, often may labor in 50 to 60 below temperature.

Cold like that makes most plastics and metals brittle and inflexible. Rubber, leather and fabrics lose their pliability and their tensile strength. Engine oils and lubricants flow sluggishly, if at all. Diesel fuels may clog fuel lines and stop engines. Tires, when left standing, develop flat spots and may shatter when moved.

CH-47C CHINOOK helicopter approaches landing on tundra in U.S. Army Arctic Test Center million-acre test area during winter operations at Fort Greely, AK, conducted by Army Aviation Test Board.

Windchill adds to the human factors peril. In extremes it may freeze exposed areas of flesh in as little as 30 seconds, thereby accenting the criticality of protective clothing. Still, when a soldier is wearing adequate arctic gear, he finds it difficult if not impossible to perform many tasks. Baring his hands to load a rifle, flip a switch or turn a latch may be an invitation to painful regret.

TECOM's responsibilities involve some 2,300 to 2,400 tests being constantly on the books. During FY 1973, records showed 942 test completions, including the M60A1E2 tank, M88E1 tank recovery vehicle, the GOER rough-terrain vehicle, new howitzers, and components for the Improved Hawk missile system.

Among other items tested were the improved Cobra helicopter armament system, the mobile floating assault bridge, new types of ammunition and fuzes, communication system components, clothing, new materials, and cargo handling equipment.

With an authorized staff of 298 military personnel and 26 civilian employes—augmented by about 200 TDY personnel during the winter test season, the Arctic Test Center conducts environmental testing on a wide range of materiel.

During the 1972–73 season, the ATC tested about 70 items including the CH47C Chinook helicopter, protective clothing, ammunition, grenades and rockets, launchers, vehicle heaters, survival kits, tents, and other cold weather equipment.

The environmental barriers to effective mobility in Alaska—mobility that is also of increasing civilian concern as preparations continue for the Alaska pipe line project to tap the huge oil reserves of the North Slope—are the basic reasons for Arctic testing operations.

Specifically, the barriers are weather extremes (temperature variations of more than 100 degrees in a 24-hour period have been recorded), problem terrain (mountains, deep snow, bogs, permafrost), radio and compass interference and deviations, and short hours of daylight for winter operations.

Aircraft have immeasurably lightened the mobility and transportation burden during the century since Alaska was known as "The Last Frontier." When Signal Corps 1LT William (Billy) Mitchell (later chief of the Army Air Corps) reported for duty on the Yukon in 1902, he had to go by dog sled from Skagway over the White Pass and down "The Big Stream."

Still many of the environmental hardships that Mitchell endured are substantially the same—extreme cold, windchill, deep snow, difficult terrain, obscuring ice fog, and other factors that impede military test operations. As one test observer expressed it recently:

"When the mercury huddles low in the bulb, the skies are dark continuously for 20 hours a day, the wind blows, and the snow is deep—mobility, thy name is molasses!" Much test personnel energy is dissipated by the basic problem of staying alive and safe.

Extremes and variations in Alaska's vast terrain (586,000 square miles) also give logisticians headaches. The state has six distinct geographic areas. Southeastern Alaska (the Panhandle) is thickly forested, mountainous, sliced by fiords, dotted with thousands of islands, and laced with tremendous glaciers.

The south central area, where Fort Richardson is located, has soaring mountains, deep bays, fast streams, and some agricultural lands and forests.

Alaska's interior is a huge rolling upland stretching from Canada to the Bering Sea, and sliced by the mighty Yukon and other powerful rivers. Towering above the rugged scenery is 20,320-foot Mt. McKinley in the Alaska Range.

Western Alaska is reindeer country, the home of 28,000 Eskimos, dotted with thou-

SSG Michael Garcia, Fort Leonard Wood, MO, takes a bearing with a new lightweight azimuth gyro surveying instrument during its winter evaluation at ATC.

THIS ARTICLE WAS PREPARED by the Army R&D Newsmagazine staff from information provided by HQ U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, MD, and HQ U.S. Army, Alaska, Office of the Public Affairs Officer. Grateful appreciation is expressed to Lyman L. Woodman of USARAL for his contribution.

sands of lakes, muskeg, and characterized by strong winds and high humidity over great expanses.

Southwestern Alaska is a land of contrasts—forested hillsides, mountains, lakes and the Aleutian Chain of hundreds of miles of inhospitable, volcanic, fog-enshrouded, wet, windy, barren islands. The sixth region, the Arctic, is rolling tundra, treeless and virtually barren—home of the caribou and currently prominent as the reservoir of petroleum and natural gas reserves.

U.S. Army Arctic Test Center operations are conducted in the 659,772-acre military reservation surrounding Fort Greely, but many of the test activities directly affect the mission interests of the U.S. Army, Alaska, headquartered at Fort Richardson. USARAL's mission is to train soldiers to fight and survive in a harsh Arctic environment, under any condition of weather, terrain or other adversities.

USARAL is a part of the unified U.S. Alaskan Command, along with the Alaskan Air Command. Survival training is linked to combat readiness and therefore to the military materiel tested in the ATC programs. In fact, the USARAL Northern Warfare Training Center is located at Fort Greely.

ATC testing facilities include Sawmill Range, used to test almost every type of weapon from artillery rounds to helicopter armament systems. The Known Distance Range is designed for testing small arm direct fire weapons under controlled conditions.

Constructed originally for the Davy Crockett weapons system, the Recoilless Range is adaptable to test almost any direct or indirect fire weapon. The TOW Range, designed to test this wire-guided missile system, has target berms at 1,000, 2,000, and 3,000 meters.

The most extensive of the ATC's indirect fire facilities is the Lamkin Range, which has two firing pads that can be operated simultaneously. The Mortar Range has "every facility needed to conduct mortar, artillery, or explosives tests." The Field Firing Range, offering 4,000 meters of rolling terrain, was constructed to test long-range, direct-fire weapons under actual field conditions, including a large variety of target configurations.

Additional ATC facilities include a highly developed Tank Range to test all types of large weapons from artillery pieces to air defense missile systems. A special Air Defense Range has been used primarily for testing air defense systems, but is termed "ideally suited" for testing any weapon or explosive.

Beales Complex is set up with extensive facilities to support several test activities at one time, as is the Small Arms Complex, which supports the Known Distance, Recoilless, and TOW Ranges. Included in the Beales Complex are seven general-purpose buildings, quarters for year-around guards, large equipment and small equipment maintenance buildings, and storage structures.

The Bolio Lake Test Site is a completely equipped multipurpose facility that can be used to support simultaneously a number of test activities. This site has supported operations of the Tank Range, Air Defense Range, and Mortar Range.

Many cross-country vehicle and ski trails lead away from the compound. In addition to serving as a staging area for field exercises and maneuvers, the site is considered ideal for testing clothing, rations and individual survival equipment.

The ATC operates and maintains the Allen Army Airfield at Fort Greely, providing an all-weather, air-support capability complete with three runways complemented by a 37,600-square-foot hangar for military aircraft. The airfield is used by both military and civilian aircraft, including heavy cargo planes up to C-141s.

Only a short distance away is a 1,000-acre clearing used for the conduct of tests on aerial delivery equipment.

Other ATC facilities include laboratories, parachute maintenance section, calibration section, photography section, vehicle section, technical library, computer equipment, and the communications section.

Materiel testing and troop training operations in Alaska place heavy emphasis on "Mobility is the Name of the Game." Increasingly, in recent years, the shift to achieve this objective has been toward air travel, including USARAL's 1969 and 1972 reorganizations which substantially reduced reliance upon mechanized ground equipment.

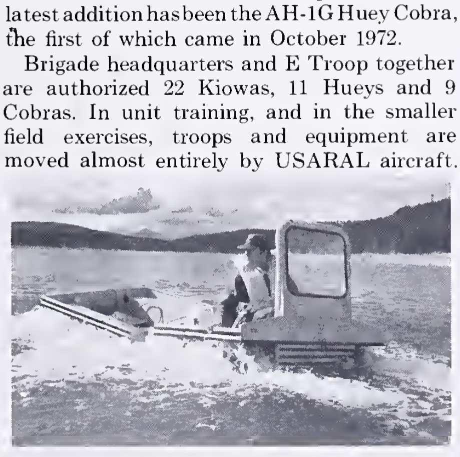
The traditional slogan of ground forces—"The Infantryman Moves by Foot"—still applies in many Arctic Test Center materiel and equipment tests and to the troop exercises of the U.S. Army, Alaska. The motive muscle power, however, is applied to skis and snowshoes in winter; hiking and mountain climbing in summer.

USARAL's main battle force is the 172d Arctic Light Infantry Brigade, headquartered at Fort Richardson, with part of its strength at Fort Wainwright. It has three infantry battalions (each with an airborne company), an artillery battalion, and supporting elements, plus Troop E, 1st Air Cavalry.

The first big thrust of the change to air mobility for the brigade came in July 1970 when the CH21 Shawnee "Flying Banana" twin-rotor helicopters were replaced by the first of a fleet of CH-47 Chinook tandom-rotor ships. Later that year OV-1 Mohawk aircraft were added to the inventory.

USARAL received three CH-54 Sikorsky Tarhe "Flying Crane" helicopters in the summer of 1971. They have been used to move howitzers, trucks and tracked vehicles, as well as sling-loaded general cargo. Operational capability was enhanced that year by arrival of OH-58 Kiowa helicopters, and the latest addition has been the AH-1G Huey Cobra, the first of which came in October 1972.

Brigade headquarters and E Troop together are authorized 22 Kiowas, 11 Hueys and 9 Cobras. In unit training, and in the smaller field exercises, troops and equipment are moved almost entirely by USARAL aircraft.



WATER COVERS MUCH of Alaska during the summer and improved methods of cargo transport across it are the continuing concern of the U.S. Army Arctic Test Center. SP4 Boyd E. Wilson, Bark Camp, KY, crosses Bolio Lake in Trail Truck.

TOW HEAVY ANTITANK missile is launched at Arctic Test Center during record-breaking low temperature. The missile streaks into the darkness at 2:30 p.m.

The 222d Aviation Battalion, USARAL's "airline," is authorized 29 Hueys, 22 Chinooks, 5 Flying Cranes, 4 Mohawks, 4 U-21 Utes, and 6 Cobras to serve requirements for transport, utility, combat, and reconnaissance aircraft.

In mass moves such as the seasonal joint services major exercises, involving hundreds of troops and much cargo, C-130s of the Alaska Air Command, C-123s of the Alaskan Air National Guard, and other transports from other active Air Force and Reserve organizations in the "Lower 48" States, also get into the action.

Flexible fuel bladder "portable filling stations," prepositioned in the field, enable aircraft to extend their range in remote areas.

Trucks and the usual tracked vehicles are, of course, also basic to U.S. Army Alaska mobility requirements. But when aircraft are "socked in" by the weather—and the snow gets deep and of such wet, soggy or dry, powdery consistency that movement by foot is more reliable—the "last resort" may be by way of skis and snowshoes.

All infrantry battalions are authorized skis. The 7-foot metal-edge skis adopted as Army standard 11 years ago are gradually being replaced with modern commercial skis. A cable-type, all-purpose binding used by the Arctic Test Center last winter was found unsatisfactory.

Snowshoes are issued to all infantry battalion members, and a few go to each supporting company and battery. Most shoes are the trail type, and include the standard 1964 magnesium model and two older wooden versions. A new binding is being tested at the ATC to replace the nylon or leather snowshoe binding.

The Northern Warfare Training Center uses the issue skis and all styles of the Army snowshoes in its courses of instruction. Hard-packed or frozen snow ridges, however, are difficult to cross on either skis or snowshoes. Deep ravines and gulleys also are common. Crossing these by muscle-power is treacherous and time-consuming—particularly where the upper levels are windswept and rocky and the bottoms are deep in snow.

Surface mobility of the infantry in the bush in winter is helped (sometimes) by use of the "sled, scow-type, 200-pound capacity." This fiberglass pull-along, called an ahkio, is used to transport a squad's field gear.

"Though inadequate," according to a test report, "it is the only means now available to

(Continued on page 18)

(Continued from page 17)

carry the tent group equipment. A requirement exists for a 100-pound ahkio to carry the equipment of a 5-man fire team."

Another R&D requirement is for an all-terrain squad existence load carrier, lightweight, air-transportable and usable in skijoring (towing the infantry squad on skis). One of the three kinds of tracked vehicle USARAL now uses almost meets this requirement. It is the M-571 articulated utility carrier made in Canada. USARAL has the

ATC COMMANDER COL David J. Schumacher (center) makes a point during Environmental Test Planning Conference conducted by U.S. Army Test and Evaluation Command at Aberdeen (MD) Proving Ground. From left are LTC J. M. Bowers, U.S. Army Tropic Test Center, Canal Zone; MG Charles P. Brown, TECOM commander; and William M. Snider, chief Test and Engineering Division, Yuma P.G.

only ones in the U.S. Army—12 in use and one in reserve.

As this carrier dies out (no parts or replacements available), USARAL will be completely without small all-terrain vehicles, a situation the command "has been fighting for years."

The ATC is testing the military potential of the commercial ½-ton payload Trail Truck for interim use during development of a desired ¾-ton payload vehicle.

Besides the M-571, USARAL has as tracked vehicles the M-548, a 6-ton cargo carrier, and the M-578 recovery vehicle. The M-548 also tows 105-mm and 155-mm howitzers. The Northern Warfare Training Center recently acquired two Thiokol tracked vehicles that are being considered for logistical support of winter field training, medical evacuation, and for packing snow on slopes where ski training is given.

USARAL has stated a requirement for a surface-effects vehicle (SEV) with a 25 to 30-ton payload capability. The SEV is conceived as a supplemental means of mobility, and not as a replacement for aviation, tracked or wheeled vehicles, command officials emphasize.

Terrain-wise, it has been determined that at least half of Alaska is navigable by SEV. There are times when, and conditions under which, a SEV might do what nothing else could accomplish in logistics, USARAL reports.

In 1972 USARAL personnel plus scientists and engineers from the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH, conducted a 7-month SEV concept experiment, using a Bell SK-5, under direction of the USARAL Combat Developments Section.

The 6½-ton craft used in the experiment was the kind that had been tested in Viet-

UNA TRACK KIT mounted on 1¼-ton, 4 × 4, M715 cargo truck was evaluated in October 1973 at U.S. Army Arctic Test Center and at Aberdeen (MD) Proving Ground as a possible mobility extender for use with Army 2-wheel-drive vehicles.

nam, having a 4-ton payload and a cruise potential of 60 miles an hour. In Alaska it was operated over all types of terrain, plus snow, ice and water, and in warm and subzero temperatures.

The Artic experiment showed that the SEV (also known as hovercraft or air-cushion vehicle) has good potential to perform in a military logistical role year-around. USARAL's report on the trial recommended that a SEV with a greater payload be acquired and evaluated by an Army Materiel Command agency.

CRREL researchers are planning to conduct an advanced field study to define more completely the military potential of the SEV in Alaska. Experimental use of a demonstration vehicle is contemplated, possibly using the 25-to-30-ton payload Voyageur made by Bell Aerospace in Canada.

USARAL also has tried both single-track and double-track snowmobiles, but the test report is that they have not proved effective for long-range operations. The rough terrain, cold extremes and varying snow conditions—plus the vast distances involved—reportedly pose difficult logistical support problems.

Members of the 1722 Brigade, which has 15 snowmobiles, set forth in March 1973, on a 1,000-mile trek from Fort Richardson through the Alaska Range and on north to Nome, Alaska. It was a test of the feasibility of such a movement and a survival training mission.

The expectation was that the trip would take 15 days. Bad trail conditions and extreme cold, plus "numerous mechanical difficulties," added four days to the estimated time. Aerial resupply kept the group going.

Snowmobiles have been used by USARAL in patrolling, carrying light loads of supplies and equipment (sometimes towing the ahkio), and skijoring. Experience to date supports the belief that the snowmobile is "better suited to recreational use than military operations."

The polar projection map shows Alaska's key position astride the Great Circle Route between North America and the Orient. That, and the fact of the 49th State's great size, puts emphasis on the need for a highly mobile, auroral-environment-trained military force, USARAL reports.

USARAL has the environmental expertise. It has great mobility under favorable flying conditions. Recognized is that there is much room for improvement with respect to suitable equipment for surface movement—particularly in summer when thousands of square miles of wet flat lands and many fast rivers are difficult to cross.

How Cold Does it Get at Fort Greely? 82d Airborne Soldiers Can Answer That

How cold does it get at Fort Greely? Emphatic language in answering that question might be used by 13 soldiers of the 82d Airborne Division, Fort Bragg, NC, who returned from nearly six months TDY at the Arctic Test Center.

Part of the time they slept in unheated tents when the temperature often was 20 degrees below zero, and one time dropped to -57. Electrodes were taped to big toes and faces to record data on physical condition during tests of protective clothing.

During the days they tested cold weather face masks, parka hoods, military skis and other cold-weather equipment. Tests included participation in airborne and airmobile maneuvers, and cross-country treks on skis and snowshoes with 30 to 45-pound back packs.

Military Radio System Marks Twenty-Fifth Year of Service

MARS, a by-word with millions of American servicemen serving overseas, who have used the Military Affiliate Radio System for low-cost telephone patches and written messages to family and friends in the United States, marked its 25th anniversary Nov. 26.

Prior to the mission transfer of the system to the U.S. Army Communications Command (USACC) at Fort Huachuca, AZ, May 1, MARS was under the Department of the Army Office of the Assistant Chief of Staff for Communications-Electronics.

The primary purpose of MARS is to provide auxiliary communications for military, civil and disaster relief officials during emergencies. It also serves to train amateur radio operators in military communications as well as handling morale and quasi-official record and voice traffic for Armed Forces personnel throughout the world.

At the time MARS was established in 1948, under authority of the Secretaries of the Army and Air Force, membership was limited to military personnel with valid amateur radio operator licenses issued by the Federal Communications Commission or under regulations of U.S. overseas commanders.

In November 1950, membership was opened to licensed civilians at least 21 years of age who had radio stations capable of operating on certain military frequencies. Three years later the age limit was lowered to 16 to permit younger radio hams to participate in MARS prior to formal military service.

As MARS enters its 26th year of dedicated service to the Armed Forces, the community and the nation, it salutes some 5,500 military and civilian operators throughout the world. Typical of the volunteers serving the system, MARS members devote more than 100,000 hours a month handling some 83,000 messages and phone-patch calls.

Ballistic Missile Defense: Facility Simulation Model

By Dr. Larry Schindler & John J. Healy

Engineers at the U.S. Army Construction Engineering Research Laboratory (CERL) in Champaign, IL, are developing a computer program that will have the capability to develop, on a simulation basis, a conceptual design and cost estimate of a total facility system for Ballistic Missile Defense (BMD) applications.

Expected to be ready for use in July 1974, the program is being developed with the help of the Huntsville (AL) Division (HND), Corps of Engineers. The HND is assisting in the development of the cost data bank, and in the performance of the final validation checks on the program's various components. The work is sponsored jointly by the Office of the Chief of Engineers (OCE) and the Advanced Ballistic Missile Defense Agency (ABMDA).

The Problem. The need for less-expensive, quick-response evaluations of hardened BMD facilities concepts was recognized by the Corps in the late 1960s. Preliminary conceptual designs usually have consumed several man-months of study team effort.

Because these studies required relatively significant investments of time, money and manpower, only a limited number of alternative designs could be examined for any given facility. OCE, therefore, initiated a study to determine means of reducing the magnitude of these investments. CERL's role was to attack the problem and solve it.

CERL engineers spent 1971–72 defining and testing possible solutions, and selecting the most promising approach. Last July (1972) they began to develop the computer program elements. Primary components are the structure module, power module, and Heating-Ventilating-Air Conditioning (HVAC) process cooling module.

The Structure Module simulates the design of the structural portions of BMD facilities to resist the effects of a nuclear attack. It provides engineers with an economical, rapid and accurate tool with which to develop, on the conceptual level, an estimate of the structural costs of a given BMD facility.

The module also can be used as an effective tool in examining various configurations of hardened structures to select the optimal one to satisfy specified requirements.

To arrive at a preliminary design, the structure module requires certain inputs. Requirements of the proposed structures—e.g., hardness level (overpressure and weapon yield), properties of the building material, ductility ratio, floor area, and shock isolation requirements—must be determined before this module of the program can be implemented.

In turn, the program sizes all members including exterior walls, roof slab and girders, column and shearwalls, and the foundation.

In addition, the module calculates the response of exterior walls, roof slab and girders, columns and shearwalls; also the usable floor area, building space, and other information which may be required as input to design other portions of the facility.

The computer program determines quantities of materials used in the facility, and prepares summaries for labor and materials cost.

The Power Module. Because BMD facilities have to be self-sufficient for the duration of an attack or battle time, they are designed with a self-contained power system. Components requiring electrical power include the radar and its support equipment, the data processor to handle information from the radar, the communications and control equipment, and the internal environment control system (HVAC and process cooling).

DR. LARRY SCHINDLER heads Corps of Engineers Advanced Ballistic Missile Defense Facilities Program and represents ABMDA in facilities area. He received a BE degree (1960) from City College of New York, master's (1961) and PhD (1968), all in civil engineering, from University of Illinois. Registered as a professional engineer in the State of Mississippi, his career includes 10 years in R&D and R&D management and two years in university-level teaching.

JOHN J. HEALY, chief, Construction Systems Division, joined CERL in 1969 as part of the original cadre. He has a BE degree from Purdue University (1945), master's in soil mechanics at Rensselaer Polytechnic Institute (1956), and has done graduate work in structures and mechanics at the University of Illinois (1963–65). After 20 years in the Navy Civil Engineer Corps, he served four years with the Army in the Office, Chief of Engineers.

The power module of the facility design simulator uses power demand of the facility and the required operating time during attack to examine various alternative power sources to select an optimal system for the facility under consideration.

The module can examine five alternative types of power systems: diesel generators, gas-turbine generators, hydrogen-oxygen fuel cells, zinc-oxygen batteries, and storable-propellant turbo-alternators.

The power module defines those characteristics of the power system which affect other parts of the BMD facility, including: the volume of space occupied by the power system, its weight, its fuel consumption and heat rejection, air intake volume (if any), and estimated initial and operating costs.

The HVAC Module identifies components that will be required on the basis of specified requirements. By examining the size and power requirements, location, weather conditions at the site, population of the facility and how it will be used with regard to internal heat generation, the module prepares a preliminary design for the HVAC. Included is an estimate of the initial investment and the operation and maintenance costs.

The computer program also selects HVAC equipment, ductwork for the facility as well as the air conditioning requirements for internal heat sources, and the floor area and volume of the facility which must be devoted to the HVAC and process cooling systems.

The Executive Program. While all three modules of the facility design simulator can be used separately to identify feasible solutions in the structure, power, and HVAC areas, the Executive Program will compare these individual solutions at their interfaces. It will make any adjustments required, and will develop a feasible solution for the facility as a whole. The interface between the structure and each of the other modules is a first step in this development.

The Cost Estimator data bank for the computer program is being developed by HND. In addition to quantity take-offs from the three primary design simulator modules, it will define costs incurred in such facilities subsystems/components such as electrical distribution, blast valves, architectural finishing, real estate, site development, and operations and maintenance.

Program Implications. The facility design simulator and cost estimator shows significant promise for reducing investment in time and cost required for planning hardened BMD facilities. A major portion of concept evaluation studies, requiring several months and costing tens of thousands of dollars when done by the typical design team will—with the use of the program—cost less than $5,000 and take less than two weeks. A typical computer run requires only 30 system-seconds on the CDC 6600.

The computer program has other advantages. It permits the examination of variations of configurations to select rapidly a cost-effective solution for the specified facility requirements. It can also be used to identify promising areas of research relevant to the design and operation of these facilities.

For example, if an advancement in battery technology would enable a facility to be powered more economically, then more research money might be allotted to such studies, resulting in long-term savings.

Individual modules of the program are currently being used in facility concept studies in support of advanced BMD system requirements. Weapons systems personnel soon will have a tool that provides them with a way to look at a number of options for defense system concepts—in a short period of time and at low study costs.

USAFSTC . . .

Serves With MIIA, MIA In Providing Intelligence To R&D Planners, Managers

USAFSTC Building, Charlottesville, VA

Scientific and Technical (S&T) Intelligence, concerning foreign technology and weapon systems critical to U.S. Army research and development planners and decision-makers, is produced by three organizations within the Department of the Army.

The Medical Intelligence and Information Agency (MIIA) reports to the Army Surgeon General, the Missile Intelligence Agency (MIA) is assigned to the Army Missile Command, and the U.S. Army Foreign Science and Technology Center (USAFSTC) is an element of the U.S. Army Materiel Command.

All elements of the Army may establish their needs and task these agencies for S&T Intelligence support through the Assistant Chief of Staff for Intelligence (ACSI), provided a need-to-know exists for specific studies, reports, and other documents.

This article, however, discusses the work of only the USAFSTC, located at 220 Seventh Street, N.W., Charlottesville, VA, about a 2-hour and 20-minute drive from the Pentagon, Washington, DC.

Like the MIIA and the MIA, the USAFSTC operations involve the processing, analysis, interpretation, evaluation and integration of information concerning:

- Foreign developments in basic and applied research in the natural and applied sciences.
- Applied engineering techniques.
- Technical characteristics, capabilities, and limitations of all foreign military systems, weapons, weapon systems and materiel, as well as R&D related thereto, and the production methods employed.

The authorized staffing of the USAFSTC is 450 civilians and 47 military personnel. About 190 are analysts with professional skills in the physical, life, and engineering sciences. They are trained for the production of finished intelligence studies, reports and briefings as authorized by Defense Intelligence Agency (DIA), the Office of the Assistant Chief of Staff for Intelligence (OACSI), and AMC.

An additional 100 professional personnel of the USAFSTC are engaged in information services or collection requirements activities that support directly the intelligence requirements of the Department of Defense.

Requests for the production of a finished study or report are levied on the USAFSTC, or one of the other production agencies, in the form of a Foreign Intelligence Production Requirement (FIPR).

Within the AMC, the FIPR would be prepared by the activity's Foreign Intelligence Officer (FIO). The FIPR is processed through channels (AMC and/or OACSI) to the Defense Intelligence Agency for approval.

The USAFSTC then is directed to prepare the report or study, although it may have been consolidated with other requirements of a similar nature by any of the approving authorities. Production of the report/study may take from 12 to 18 months, with each of the requesting agencies receiving a copy when distribution is made.

Meanwhile, the requesting agencies will be on distribution for any current intelligence products that may provide partial answers to their questions. Current intelligence products authored by USAFSTC analysts include the Weekly Wire, the Biweekly Scientific and Technical Intelligence Summary (BSTIS), and the Army Scientific and Technical Intelligence Bulletin (ASTIB).

Distribution of the Weekly Wire is limited to about 40 addressees, mostly general officers and key civilians. The BSTIS is targeted specifically at the AMC laboratories and arsenals through their FIOs, but does reach other "subscribers." The ASTIB is published by the Adjutant General's Office and receives wide distribution within the Army.

Quick reaction tasking may also be levied on USAFSTC when the normal FIPR route will not provide timely intelligence. When a reply is needed within 10 days, and the capability exists within the Center to produce the required intelligence, the USAFSTC is authorized to reply directly to such requests.

Information is supplied to many customers based on their Statement of Intelligence Interest (SII), which, within AMC, will be prepared by an FIO and then sent to USAFSTC for action. Responses to an SII, however, provide only raw, unprocessed information—not finished, analyzed intelligence.

Special intelligence reports and studies also may be ordered from the USAFSTC. Knowledge of many such reports may be gained through the Central Information Reference and Control (CIRC) system. This tri-Service information storage and retrieval system is operated by the Foreign Technology Division, Air Force Systems Command for the DIA.

The CIRC data base exceeds 800,000 reports and is primarily from the Soviet Bloc open source literature dating to 1963. Supplementing this source, for information on countries and subjects not available through the CIRC, is SATIRE (Scientific and Technical Information Reviewed and Exploited).

SATIRE, published by the USAFSTC, includes contents of periodicals, abstracts or extracts of material as requested by users, and book exploitation reports or annotated tables of contents for selected monographs and short translations.

When the USAFSTC is not able to provide requested information from internal holdings, every effort is made to tap external sources such as the Library of Congress, DIA, Central Intelligence Agency, Atomic Energy Commission, and Libraries of other U.S. Government agencies.

Finally, when all these sources fail to yield the desired information, the USAFSTC may prepare an Intelligence Collection Requirement (ICR). When approved by the DIA, this serves as a means for worldwide collection of information as specifically requested.

From the above it should be apparent that a considerable amount of scientific and technical intelligence is available for the asking. The policy is: "Ask, and the USAFSTC will do its best to supply your needs."

COL ROBERT A. J. DYER, commander/director of the USAFSTC since June 1972, and previously chief of the Foreign Science and Technology Division, Research, Development and Engineering Directorate, Army Materiel Command, is a 1966 graduate of the Army Command and General Staff College. A Master Army Aviator with more than 25 years of military service, he is a native of Little Rock, AR. He has served in China with the Flying Tigers, in Korea with the 7th Infantry Division, in Hawaii with the 25th Infantry Division, and in Vietnam with MACV's Combat Operations Center as the staff officer for the Army Aviation Division.

DR. JOHN A. ORD, deputy director of the USAFSTC since July 1966, joined the Philco-Ford System Technology Center management staff following retirement from the Army in 1965. He served in R&D assignments with the Army Materiel Command (1962–65) and on the Army staff (1955–58), where he organized the Army Research Office. Other assignments included deputy signal officer, U.S. Armed Forces Far East Japan; and as director of training, Armed Forces Special Weapons Project, Sandia Base, NM. He has a doctorate in science from Carnegie Institute of Technology and is a graduate of the National War College, and the Army War College.

A New Fluidic Concentration Sensor

By Robert L. Woods and James W. Joyce

Many situations require the measurement of the concentration of one gas in another. Examples include the measurement of carbon dioxide (CO_2) in exhaled breathing gas, CO_2 levels aboard space vehicles in an oxygen-nitrogen environment and CO_2 and oxygen (O_2) levels in a primarily helium (He) environment for deep-sea projects.

Among drawbacks of most current gas concentration analysis devices are that they are too expensive, not portable, and too time-consuming for measurement.

A fluidic gas concentration sensor that overcomes some of these shortcomings was developed at the Harry Diamond Laboratories (HDL) in 1970. This device contains two flueric oscillators that generate frequencies proportional to the density of the gas samples. Since two oscillators are used, concentration relative to a reference gas can be measured. These AC signals must be processed electronically (or fluidically) to determine the relative concentration.

A more recent development at HDL has produced a simpler, more desirable fluidic concentration sensor that generates a direct analog pressure signal proportional to the relative gas concentration in a continuous manner.

The sensor consists of a passive resistor bridge into which sample and reference gases are entrained. The output signal from the resistor bridge can be fluerically amplified to provide a sufficiently large output signal that can be detected by inexpensive transducer/readout systems. The system offers small size, low expense, and fast response time with accuracy and resolution far exceeding requirements of many present applications.

The main component of the sensor includes two flow channels consisting of linear resistors (laminar flow resistors) and nonlinear resistors (orifices) as shown in Fig. 1. A constant negative pressure, P_b, is applied to the bridge so that the reference and sample gases can be drawn into the sensor from ambient pressure.

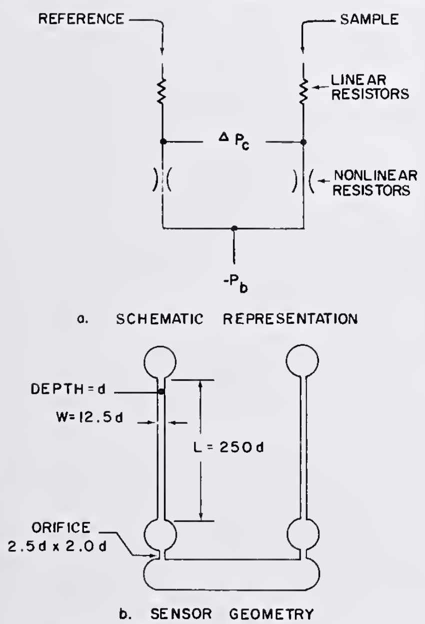


Fig. 1. Fluidic resistor bridge concentration sensor

The pressure at the point between the two resistors in the sample branch varies with the concentration of the gas to be measured due to changes in viscosity and density of the mixture. For low concentrations, the pressure difference, ΔP_c, between this point in the sample gas branch and the pressure at the corresponding point in the reference gas branch can be approximated by the following equation:

$$\frac{\Delta P_c}{P_b} = G\,k\,X$$

where

G = a gain constant dependent upon sensor geometry and reference gas properties (maximum absolute value = 0.1716)

k = gas sensitivity constant dependent upon the density and viscosity of the sample gas relative to the reference gas

X = volume concentration of the gas to be measured in the sample gas. Thus, for a given gain constant, the relative sensitivities of various gas combinations can be represented by the relative values of k. Table I shows the theoretical values of k for a number of gases.

Data were gathered with mixtures of CO_2 in air. Experimental hardware, Fig. 2, consisted of brass laminates sandwiched between two plexiglas plates (thermal insulators) and two brass plates, with identical flow channels, one for the sample gas and the other for the reference gas.

The unit also contains a high-gain laminar flueric proportional amplifier with a pressure gain of 26, which for this application was operated with suction applied to its vents.

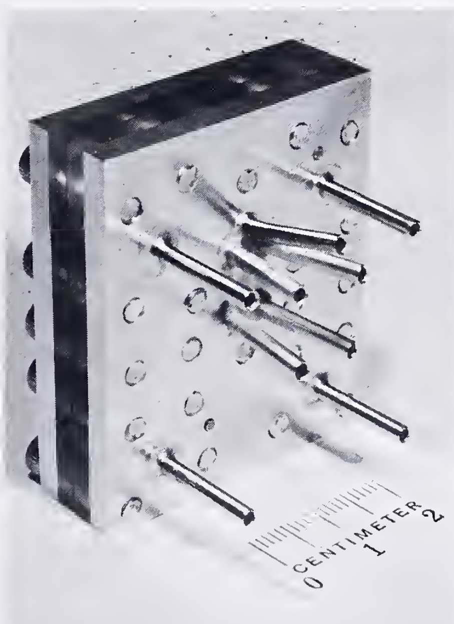


Fig. 2. Experimental hardware

The flueric sensor was operated with a bridge pressure, P_b, of 20 kPa (2.90 psi) and the amplifier with a vacuum, P_v, of 12.5 kPa (1.86 psi) applied to the vent region. The flow through each channel of the sensor was 2.8 cm^3/sec (0.168 1pm) and the flow aspirated through the amplifier approximately the same.

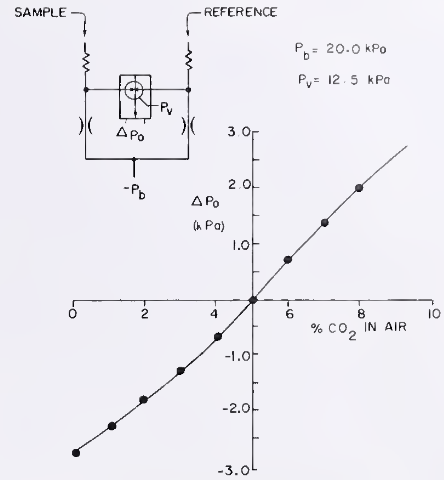


Fig. 3. Sensor output characteristics

Fig. 3 illustrates the sensing capability of the bridge with the high-gain amplifier. The output differential pressure changes by about 5.5 kPa (0.8 psi) for a change of 10 percent CO_2. This signal can be monitored with conventional readout equipment (e.g., inexpensive transducer or pressure gauge). The slight nonlinearity in this curve is introduced by the characteristics of the amplifier.

The only significant dynamics in the sensing system are the time delay from gas source to sensor and the time lag in the readout device. These lags are usually insignificant; however, trade-offs could be made if it were necessary to improve the response time.

Results of the experimental tests indicate that the sensor is capable of measuring from 0.01 to 100 percent CO_2 in air. Although actual output readings are dependent upon variations in bridge pressure, temperature, humidity, amplifier gain, etc., most parameters can be controlled to expect an accuracy equivalent to better than $\pm 0.1\%$ CO_2 in air. The sensing system, including the resistor bridge, flueric amplifier and an aspirator to create the suction pressures required, can be packaged in a laminated, diffusion-bonded stack. The result would be an inexpensive, small, durable system that in some applications would require no electronic instrumentation.

TABLE 1

Sample Gas	Reference Gas	k
CO_2	Air	1.08
CO	Air	0.09
O_2	Air	-0.11
H_2O	Air	0.66
H_2	Air	-0.90
NO	Air	-0.02
N_2O	Air	1.07
SO_2	Air	2.41
H_2S	Air	1.07
CH_4	Air	0.28
C_2H_6	Air	1.63
C_3H_8	Air	2.98
C_4H_{10}	Air	4.25
C_5H_{12}	Air	5.48
O_2	He	4.83
CO_2	He	9.76

SPEAKING ON . . .

(Continued from inside front cover)

complex and costly as other arms might require. In addition, the infantryman benefits from developments for the other materiel areas. His main requirements are for small arms, clothing and support equipment.

The infantryman needs a new rifle sometime in the future that will use the same ammunition as his automatic weapons. He needs a manportable antitank weapon with

ARMOR

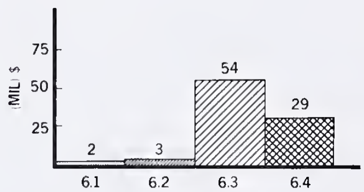


Figure 3

greater firepower, range and hit probability. He needs better protective equipment, better personnel armor. He needs great improvement in detecting and removing his most recent and most destructive threat—mines.

All of our efforts grouped under the heading of "Individual Soldier" also tend to be directly supportive of our infantryman. He will be the greatest benefactor of General Abrams' announced goals of improved readiness, tactics, leadership, training, motivation and support.

Armor operations, like infantry operations, include a complex association of combat units. A combination of tanks, vehicles, supporting artillery, and air cavalry is involved. The funding support of this combat area, shown in Figure 3, is the least visible of any in our R&D budget structure. With the exception of support for the XM-1 tank, funding for other armor-related developmental efforts is minimal.

A number of big questions need to be answered to improve armor operations technology. The target acquisition problem for both ground and air targets needs to be solved. Although the principal threat to a tank is generally considered to be another

FIELD ARTILLERY

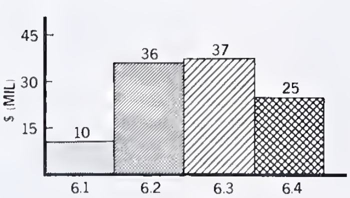


Figure 4

tank, advanced technology has now made the tank vulnerable to air-launched weapons.

Much attention is being given to the relationship of mobility and agility to survivability. A comprehensive simulation methodology is required to determine the effectiveness of mobility on the battlefield. Simulation experience to date points toward the necessity of a more agile tank system.

The adoption of such a goal would call for increased attention to improve tank propulsion units. A more agile tank would also demand a better stabilized gun mount, faster target acquisition and sighting, and nearly automatic tracking and firing—all in an over-all sequence of a few seconds.

Field artillery support for both gun and missile systems is shown in Figure 4. The largest problem needing answers is achieving quicker first round fire-for-effect through better gun and target location and application of corrections. Efforts toward improving our capabilities for locating the target and expediting the processing of firing data for artillery are receiving increased attention. Our intent is to exploit technological advances to enhance first-round hit and kill.

AIR MOBILITY

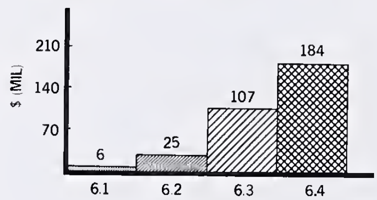


Figure 5

We need to move ahead in our capability for terminal homing on targets, to strive for a truly launch-and-forget system, using whatever passive sensory systems we can devise that sorts target data from background noise. The potential in this direction is tremendous.

We also need to take a new look at inexpensive free rockets for direct and indirect fire. We need to realize all of the potential that the soft-recoil system promises. We need to work in the direction of automating our field artillery combat units. We need to pursue numerous opportunities to modernize and improve the effectiveness of field artillery firepower.

Air mobility funding is presented in Figure 5. One characteristic of this program lacking in the others is the "Complete Machine" concept in which subsystems are co-developed with major end-items. An example of this is electronics. This technology is not identified directly with any of the other combat areas; however, it is an integral part of the aviation package—avionics—and work in this field parallels new aircraft development.

Air mobility R&D also stands out as a vivid example of a well-integrated and balanced effort in each stage from basic research to system deployment. Funding is progressively greater as requirements are defined. Elements, readily identifiable with air mobility, contribute to components that in turn are used to build systems.

A comparison similar to the air mobility program cannot be extracted from the budget data for any other combat area. No other combat area is also so visible to Congress. The requirements for aircraft in terms of the UTTAS, AAH, HLH, and Aerial Scout should also be well known to industry.

We do need to extend aircraft night-operation capability. We also need new approaches to aircraft survivability and means to promote aircrew safety and survivability.

AIR DEFENSE ARTILLERY

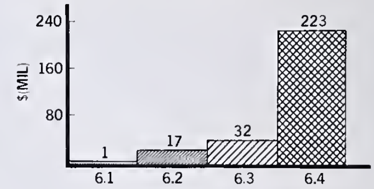


Figure 6

Other air mobility related needs will be mentioned later in this presentation.

Technology base support of air defense is difficult to identify. Most of the effort in Air Defense is in Engineering Development for systems such as LOFAADS (Low Altitude Forward Area Air Defense System), Stinger and SAM-D (See Figure 6). One of the dominant goals of future air-defense systems is a multimission capability to attack both surface and airborne targets. Consequently, many missile and gun technology studies tend to lose their identity with air defense as a distinct mission. Certain advanced aspects of

BALLISTIC MISSILE DEFENSE

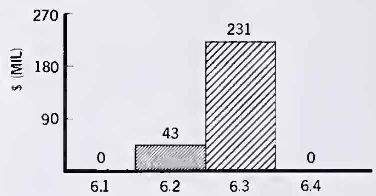


Figure 7

ballistic missile defense, such as propulsion and radar, are also applicable to future air-defense missions.

Over-all, the needs of air defense can be summarized as: higher burning rate missile propellants; better IFF techniques; improved sensors and seekers; integrated radar-electronic warfare capability; and multimission warheads.

As depicted in Figure 7, there are no Army programs in 6.1 research and 6.4 advanced development that may be tagged as directly contributing to BMD (Ballistic Missile Defense). Work in air defense and electronics provides secondary contributions to BMD. In fact, before FY 73, all BMD effort was tagged to 6.3. A new exploratory development project was structured with the realization of the long-range nature of technology needed to upgrade BMD systems.

We need cheaper and simpler approaches to BMD. We need greater propulsion capability, with attention focusing more immediately on the advanced terminal interceptor. We need to think ahead to the next generation of the BMD solid-state radar. We need to work out better ways to handle all the data that this new radar will generate.

BMD system software is called upon to perform all engagement tasks including designation and discrimination of the threat, tracking of reentry objects, allocation and guidance of interceptors, and internal-defense system operations. The magnitude and complexity of the tasks are great; complete real-time control software requires hundreds

of thousands of instructions and hundreds of man-years of development effort.

A primary goal of the software program is to devise methods for building software faster and cheaper with enough flexibility to allow changes to be made quickly. We need to improve our optical sensors to make them more sensitive, more reliable, and more discriminatory. We need to do all of these things in the environment of the Strategic Arms Limitation Agreement and the arena of redefined objectives.

Each of the areas that I have briefly mentioned depends, in some way or another, on

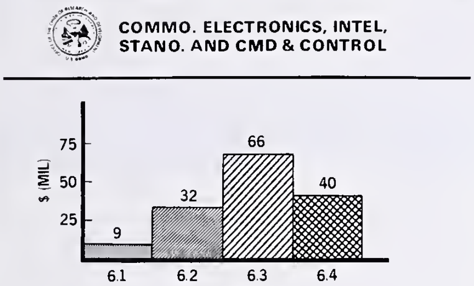


Figure 8

the advancements that can and are being made in communications and electronics devices, Figure 8. There is more unused potential for advancement and change as the result of the application of electronic devices to future combat than any other technology I know.

Besides applications already mentioned, we need to take a giant step forward to the real time command, control and communications systems of tomorrow's integrated battlefield control system. We must make greater use of satellite communications for reliable source links from point to point. We must build greater security into tactical communications.

We must also plan for alternative back-ups and protective means in case of failures or breakdowns at any point in our integrated systems. We need a new generation of electronic warfare and night-vision devices. In support of all gadgetry, we need to take a renewed look at the electrical power sources that are essential in the smallest to the largest devices functioning.

I will now discuss the technology base which will be the source of future Army weapons systems. In budgetary language, the technology base is a combination of research, exploratory development, and nonsystems advanced development efforts. The Army technology base is about one-fourth of the total Army RDTE (Research, Development, Test and Evaluation) budget. As Director of Army Research, I am responsible for Army General Staff supervision of the technology base.

Within the technology base, emphasis is being placed on the following areas: Individual soldier; medical technology; laser technology; nuclear effects; air mobility; electronics; propellants and explosives; environmental factors; ground mobility; computer technology; and military energy conversion. This list is in approximately descending order of priority, but not necessarily in order of dollar ranking, and I now will comment briefly on each of the 11 areas.

Effort in support of the individual soldier involves not only enhancing ability to defeat an enemy. Important also is the protection of the friendly soldier—increasing the likelihood of his surviving and avoiding injury while doing his assigned job. Research on better personnel armor and aircrew and combat vehicle safety is part of the effort directed to this purpose.

Most of my comments have been hard sciences-oriented. Behavioral and Social Sciences, however, are increasing investigation of new training, education, and leadership evaluation as part of the emphasis on helping the individual soldier.

Improved field medical techniques offer another contribution to this goal.

Laser technology, both low- and high-energy, is expanding with needs covering such topics as new frequency regimes, improved reliability, communications applications, atmospheric interaction, increased power utilization efficiency, new designs, detection and defense techniques, and protection of personnel.

Nuclear effects mainly involve detection and assessment of the interaction of electromagnetic pulses with materials, system components, and communications.

Air mobility needs are primarily in the direction of reduced specific fuel consumption, increased thrust per unit weight, and the substitution of composites and other materials into airframe construction for greater reliability. Ground mobility objectives are geared toward the ground-mobility model reported in the July-August 1973 *Ordnance Magazine. Magazine.*

Our electronics efforts are aimed in the direction of greater miniaturization, increased reliability and maintainability, reduced cost and interoperability.

Work on propellants for guns is being done with the intent of improving the understanding of combustion and ignition processes. Our explosives work is primarily in support of a planned modernization of our explosives manufacturing capability to reduce costs and pollution. Other environmental programs are under way to reduce ground vehicle and aircraft emissions.

Another goal is to develop an automated meteorological data-gathering, interpretation, and distribution capability, with output as near real-time requirements as possible.

We are capitalizing on our computer technology base through development of improved software, increased utilization of computers, and interoperability.

Army efforts on military energy conversion still emphasize the upgrading of electrical power sources for all Army applications. National policies on the energy situation may soon dictate revised goals to our program.

An increasing trend is to strengthen the technology base. This is especially important because of the long-range parallel trend now developing to use the technology base for life extension of existing weapon systems through an upgrading of major components. This latter trend is supported by the fact that there are no big system new starts scheduled by the Army in FY 74.

Discussions behind the scenes also indicate more planning for product-improved systems. During the past year we identified four general goals for the technology base, which could be just as applicable for all Army RDTE efforts. These goals are:

- Technical superiority
- Cost avoidance
- Improved reliability, availability, maintainability
- Increased human effectiveness

In addition to the emphasis on relevance, we are filtering our programs through these goals. Our observations to date have been most encouraging, even for our university research investigations.

In closing, I should touch on what I feel is one of the greatest needs of Army research and development—a need still searching for a solution. Industry is involved in only about one-third of our technology base efforts, and three-fourths of our development effort, but is the producer of most of our weapon systems. What these figures say is that we may be waiting too long to bring industry into our conceptual thinking for technological improvements, advanced components and new systems.

We could strengthen our technology base even more by reaching out to industry for help. Together we should explore new ways of increasing our technology interchange, improving our informal communications and clarifying our needs in a common endeavor of strengthening our technology base and assuring the most efficient and effective utilization of our technical assets.

Atmospheric Sciences Theme Review at NCAR

(Continued from page 9)

Study of the Diurnal Mountain-Valley Wind Circulation, Wen Tang, Institute for Storm Research, University of St. Thomas; Trace Chemicals in Tropical Atmosphere, Dr. John Pate, NCAR; and

Propagation of Infrasonic Waves in the Atmosphere, Dr. N. K. Balachandran, Columbia University; Measurement of Tropospheric Structure with A High Resolution Lidar, Dr. Edwin W. Eloranta, University of Wisconsin; Development of Drop Growth Theory in the One-Half to Ten Micron Size Range, Dr. J. C. Carstens, University of Missouri-Rolla; Relative Importance of Vapor Deposition and Contact Nucleation in Cloud Seeding with AgI, Dr. Ulrich Katz, Calspan Corp.; Modification of Cyclone Scale Precipitation, Dr. Ferdinand Baer, University of Michigan; and Precipitation Scavenging of Organic Contaminants, Dr. R. N. Lee, Battelle NW Labs.

About 50 scientists from Army laboratories, the Boulder research community, and research organizations supported by ARO attended the meeting. Dr. John Firor, director of NCAR, gave the welcome address.

Session chairmen included Dr. David Atlas, chief of the Atmospheric Technology Division, NCAR; Dr. Arthur Dodd, director of the Environmental Sciences Division, ARO; Marvin Diamond, deputy director, Atmospheric Sciences Laboratory, WSMR; and Dr. Leo Alpert, chief of the Atmospheric Sciences Branch, ARO.

Dr. Hermann Robl, ARO chief scientist, chaired an executive session at which the quality of the present program was reviewed.

Army Considers Feasibility of Helicopter Advancing Blade Concept

By Harvey R. Young

The Advancing Blade Concept (ABC) in helicopter design is a coaxial, counterrotating, "rigid" rotor with several potential advantages over "standard" rotor systems.

With this concept, the feasibility of which will be tested this fall, the aerodynamic lift in forward flight is carried primarily on the advancing blades and is not limited to the lift that can be developed on the retreating side of the rotor disc. Thus, problems of retreating blade stall are largely eliminated.

As with other coaxial helicopters, a tail rotor is not required for antitorque purposes; yaw control at lower speeds is produced by differential main rotor torque.

Without flapping hinges, lead-lag hinges, and associated hardware, the rigid rotor eliminates the maintenance normally required for these components. Super-stiff rotor blades preclude excessive deflections under high loads and permit rotor slowing for high-speed applications where the advancing blade tip Mach number must be kept below approximately 0.85.

Potential advantages may be summarized as follows: (1) ability to overcome some of the aerodynamic limitations of conventional rotors, (2) superior maneuverability, (3) reduced complexity, (4) deletion of tail rotor and associated hardware, (5) compact configuration, and (6) high-speed capability with horizontal thrust augmentation.

With all these possibilities, why then has it taken so long for this concept to evolve into a flight test program? The answer is technical risk, in this case, the uncertainty of being able to accomplish in the real world what is theoretically possible on paper.

The uncertainty includes the inability to predict, with a high level of confidence, acceptable dynamic behavior of the rotor system throughout the entire spectrum of ground and flight conditions. Then there is the difficulty of even predicting forcing functions accurately, due to rotor-rotor interference and similar effects. Some decades ago a flapping hinge was invented to solve blade stress and dissymmetry of lift problems, yet the ABC reverts back to a design that not only prevents (conventional) blade-flapping but compounds the stress problem by using increased blade loadings.

The fundamental challenge of ABC design was to arrive at an acceptable rotor system compromise. The rotor must be aerodynamically efficient with respect to lift/drag ratio. It must also be structurally capable of reacting to extremely high bending moments, yet light enough to keep from defeating the entire concept!

Several programs were undertaken by Sikorsky Aircraft Division, developer of the ABC—initially to explore the possibilities of this rotor concept and later to reduce the technical risks enumerated here.

Programs included both theoretical work and actual tests with experimental hardware. They dealt primarily with materials and manufacturing technology, design concepts, and wind tunnel programs.

Materials investigation showed that titanium, with the proper metallurgical characteristics, could be produced in a usable form, with fatigue allowables nearly twice those previously considered for titanium. This meant that the weight penalty previously associated with a nonflapping, highly loaded rotor could now be kept within tolerable limits.

Advancing blade concept research vehicle (artist's concept).

One of the more significant events was wind tunnel testing of a full-scale, 40-foot-diameter ABC rotor in the NASA-Ames 40′ × 80′ wind tunnel. During this program, the rotor was tested at 25 combinations of flight conditions, up to a maximum advance ratio of 0.91 and up to an advancing blade tip Mach number of 0.83.

Although the wind tunnel tests were not comprehensive, the results verified the aeromechanical stability and structural integrity of the rotor under the conditions tested.

In December 1971, the Eustis Directorate of the U.S. Army Air Mobility R&D Lab at Fort Eustis, VA, awarded a contract to Sikorsky Aircraft Division of United Aircraft to design, fabricate, and flight test an ABC-configured research aircraft.

Specific aircraft design requirements were kept to a minimum to permit the necessary trade-off flexibility in arriving at a balanced but, of necessity, highly compromised design. Aircraft target design speed was 140 to 170 knots in the pure helicopter mode and up to 300 knots in the auxiliary propelled helicopter mode, using two J-60 turbojets to provide the horizontal thrust.

The target design point was hover out of ground effect at sea level, 95° F. at design gross weight in the compound helicopter configuration. Maneuver objectives were rather severe for the basic helicopter and included the ability to achieve sustained load factors of 2.5g in the speed range of 70 knots to 170 knots with satisfactory maneuvering stability and stress levels in all critical components limited to not more than 150 percent of their fatigue endurance limits.

Primary emphasis was placed on acquisition and analysis of rotor data to be obtained during the flight program. Typical areas to be investigated included:

- Rotor behavior during a broad spectrum of test conditions.
- ABC rotor inherent capabilities, limitations, and best operational conditions.
- Demonstration of concepts and theories originating from analytical studies and wind tunnel tests.
- Dynamic loads, vibrations, stability, control and flying qualities, flight control systems, maneuver capability, autorotational entry, and aerodynamic performance throughout the operational flight envelope.

Under the existing contract, two ABC research aircraft are being fabricated and a flight test program of 50 hours will be conducted. To substantiate the structural integrity of the rotor and drive system, a Propulsion System Test Bed (PSTB), capable of testing all dynamic components as an integrated system, will be operated for 100 hours.

Prior to the first flight, the PSTB will be operated for 50 hours at load levels in excess of the predicted flight loads. The last 10 hours of this testing must be accomplished uninterrupted by any significant malfunction.

Additionally, a minimum 2:1 ratio of PSTB test time to flight time must be maintained throughout the flight test program. Also, a differential of at least 40 hours must be maintained between PSTB test time and flight test time.

The PSTB was successfully operated for the first time Feb. 28, 1973

HARVEY R. YOUNG is assigned to the Systems Support Division, Eustis Directorate of the U.S. Army Air Mobility R&D Laboratory (AMRDL), Fort Eustis, VA.

Prior to joining AMRDL in 1967, he worked as a design engineer for a private aircraft corporation and was with the U.S. Army Aviation Systems Command, St. Louis, MO.

Currently serving as the Army's project engineer on the Advancing Blade Concept, he is responsible for planning, organizing, and conducting exploratory and advanced development phases of flight mechanics programs. Other R&D efforts have included the Heavy Lift Helicopter, Advanced Flight Controls for Helicopter, Twin Helicopter Lift System, and the Advanced Geometry Blade.

He graduated from Washington University, St. Louis, MO, in 1958 with a BS degree in mechanical engineering and has done graduate work at George Washington University.

with only power-absorbing clubs installed. The present schedule calls for installing the rotor blade sets and initiating the rotor stress and motion/dynamic response survey in May 1973. If this test is successful, endurance testing will follow.

Flight testing is scheduled to begin in August 1973, contingent upon the outcome of all the laboratory tests, bench tests, ground tests, etc.

One of the most important questions to answer is: Which results are truly germane to the ABC and which are incidental to the test program? In trying to answer this question, several others must be answered first.

For example, what was the magnitude of the design compromise in building the research aircraft to provide the capability for both conventional and high-speed flight? What performance gains would be realized by pre-tilting the rotor/transmission forward to reduce drag for conventional speeds, or by tilting the rotor/transmission backward for optimizing high-speed flight?

Other questions are: What would be the over-all advantage of using high-modulus material in the blade spars to reduce weight, drag, and vehicle height? What is the feasibility of reducing the size of the transmission/rotor shaft through redesign or new materials? What penalty is associated with using two turbojet engines for horizontal thrust and two additional engines for lift rather than two convertible fan shaft engines as combined lift/thrust engines?

Researchers also want to know how much rotor maneuver "muscle" is actually usable, i.e., what maximum angular acceleration is the rotor capable of producing within the constraints of blade tip clearances and stresses, and as limited by opposing moments generated by a horizontal stabilizer sized to meet static stability criteria?

Testing also will yield information on the benefits and penalties that might result from incorporating a more sophisticated flight control system to improve handling qualities. (The present design is strictly a mechanical push-pull system, without stability augmentation but with ground adjustable features as well as provisions for varying gains and control couplings electrically in flight.)

Flight test data will be analyzed in depth. Load predictions and design criteria will be compared with actual measurements. The amount of "over" or "under" design of components will be estimated and translated into weight savings or penalties.

Vibration characteristics will be examined to determine the vibratory "g" levels at the pilot station and at a transmission mount. Dynamic interaction between fuselage and rotor components which produces spurious loads and which can be attributed to a simple dynamic mismatch (correctable) will, hopefully, be sorted out.

Aerodynamic performance will be reviewed critically in an attempt to calculate rotor L/D ratios, figure of merit, propulsive force limitations, specific range, etc. Pilot work load and stability characteristics will be examined and problems classified with respect to those believed solvable using proven techniques in artificial stabilization.

The need for basic changes in the control system, including feedback devices, will be evaluated. Control power, damping, and response, particularly about the yaw axis, will be compared with MIL Spec requirements and other helicopters.

In addition, qualitative assessments will be made of the maintainability and reliability implications, the compact configuration, lower noise signature potential, etc.

Through testing the entire ABC aircraft in a helicopter environment and permitting the various subsystems and components to interact dynamically, we will be able to judge the feasibility of this concept. The data necessary to make this judgment should start arriving in the near future.

AMRDL Grants $5 Million for Helicopter R&D Effort

Efforts to advance the state-of-the-art of Army helicopter performance and maintenance are being extended through $5,078,757 in recent research contracts awarded by the U.S. Army Air Mobility R&D Laboratory (AMRDL), Moffett Field, CA.

Six contracts with Bell Helicopter Co. totaling $1,224,000 include an $820,000 effort to instrument and flight test an Army AH-1G helicopter to obtain data that will be used in the formulation of realistic design criteria. The objective is to develop helicopters with improved maneuvering capabilities.

Bell Helicopter Co. also will expand a ballistic-damage-tolerant flight-control program under a $149,000 contract; also, identify ways to reduce vulnerability of the AH-1G to groundfire under an $89,000 contract.

Other Bell contracts include $87,000 to format AH-1G operational, maintenance and combat statistics and to simulate alternative mission, maintenance and configuration concepts; and $79,000 for an evaluation of reliability growth achieved during development of selected helicopter systems.

Two contracts totaling $936,000 with Lockheed-California Co. include a 2-year, $839,000 research effort to determine icing severity levels that Army helicopters of the future are expected to meet during bad weather.

Another $97,000 task is to investigate the use of a composite geodesic structural concept to design helicopter main-rotor blades tolerant to light antiaircraft projectile impacts.

Under a 2-year $645,000 contract, General Electric Co. will develop manufacturing methods and technology and establish pilot production capability for fabricating small air-cooled axial-turbine blades, discs and cooling plates.

A $538,000 contract with Hughes Helicopters, Division of Summa Corp., will seek to extend composites technology for aircraft structural applications.

Three contracts totaling $381,000 with Boeing-Vertol Co. include $193,000 for research on helicopter small-hardware designs to improve reliability and maintainability.

A one-year $99,000 exploratory development contract calls for design, fabrication and evaluation of three improved rotor-blade designs for future Army helicopters. An $89,000 contract is for development of an improved active-arm, external-load, stabilization system for Army helicopters.

A $246,000 contract with Sikorsky Aircraft Division of United Aircraft Corp. is for fabrication of a full-scale, rotor-blade, fatigue-test machine to provide the Army with the capability to evaluate advanced rotor-blade design concepts.

Design criteria for elastomeric bearings for helicopter rotor and control systems is the goal of a $230,000 contract with Wasatch Division, Thiokol Chemical Corp. Kaman Aerospace Corp. received a $127,000 contract for research aimed at reducing the maintenance costs of future Army aircraft by simplifying removal and replacing of components and subsystems.

A $114,000 contract with Goodyear Tire & Rubber Co. involves design, fabrication and qualification of an improved fuel-tank material capable of self-sealing protection against ballistic projectiles to meet helicopter crash-worthiness requirements.

Under a $100,000 contract award, Pratt & Whitney Aircraft Division of United Aircraft Corp. will develop a laser optic probe for measurement of running clearances in small gas-turbine engines. Dynamic Science, Division of Ultrasystems, Inc., was awarded a $99,757 exploratory development contract to evaluate two restraint system designs for Army helicopter troop-seat occupants.

An Aircraft Reliability and Maintainability Simulation (ARMS) analysis technique will be developed by the RAIL Co., Baltimore for $98,000. Detroit Diesel Allision Division, General Motors Corp., will receive $97,000 to test a computer program to predict performance of centrifugal compressors.

Under a 15-month $93,000 contract, Solar Division of International Harvester Co. will develop a turbine-blade temperature measurement system for small gas-turbine engines. AVCO Lycoming Corp. will analyze the cost of the T53 gas-turbine engine for $81,000.

Mechanical Technology, Inc., will be paid $69,000 to develop a new technique for diagnosing the condition of helicopter transmission bearings by analyzing high-frequency sounds produced when they are worn.

IMPROVEMENT OF AIRCRAFT CRASH RESCUE capabilities is the objective of an experimental testing program for a Heliborne Fire Suppression System conducted recently over a 30-day period. Under the operational control of the Sanitary Sciences Division, Military Technology Department, U.S. Army Mobility Equipment R&D Center, Fort Belvoir, VA, the tests were supported by the U.S. Army Aviation Test Board, Fort Rucker, AL, with William J. McNamara as project officer. Phase I (12 operational days) involved use of different orifice combinations over various foam quantity/distribution patterns Phase II (18 days) used data from Phase I and testing in 1972 to fight fuel fires simulating aircraft crash fires.

Women in Army Science . . .

Equality of Opportunity . . .

Microbiologist Achieves National Prominence

Equality of opportunity was barely a still, small voice in the wilderness trying to gain an audience for the cause of blacks, women and minority groups when Miss Dorothy McClendon embarked on a career as a U.S. Army scientist.

Today, 21 years later, she has achieved outstanding success in doing her own thing to break the barriers—a black woman who is nationally known, has established her own basic research microbiology laboratory, has earned a rewarding succession of honors, and is eminently respected by associates.

Selected recently by the Detroit branch of the Federal Executive Board as being one of the best in her profession, Miss McClendon is engaged in basic research to develop a technique of introducing a nontoxic fungicide into military storage facilities—to protect materials without harm to humans.

During more than two decades of microbiological research with the U.S. Army Tank-Automotive Command, Warren, MI, she has had prominent roles in experimentation on deteriorating effects on components of such missile systems as Redstone, Honest John, Little John, and Jupiter. She has published numerous reports related to her studies on the effects of radiation on microbes.

When she started with TACOM, her first work was in the physical sciences. About a year later she began to establish a basic microbiology laboratory. She cultured her own pure strains of fungi which were exposed to various types of military materials and materiel, leading to knowledge valuable in procurement of items best suited for humid-tropical environments and long storage. Since 1958 she has been the only microbiologist employed by TACOM. In 1964 she was honored as one of Detroit's 10 top professional women.

A member of the American Institute of Biological Sciences, she has a 1948 BS degree in microbiology from Tennessee A&I University, Nashville, and has done graduate work at the University of Detroit, Wayne State and Purdue Universities.

Stimulating Strides in Science . . .

Cited by National War College Graduate

Women have made stimulating strides in the wonderful world of science in the past 25 years, in the opinion of the first Department of Defense civilian female employe to graduate from the National War College in Washington, DC.

Mrs. Pythagoras Cutchis

Mrs. Pythagoras Cutchis is a top echelon planner for the U.S. Army as a GS-15 employe who heads the Systems Integration and Analysis Directorate, Concepts Analysis Agency, Bethesda, MD. Although she is in sympathy with most Women's Lib thinking, she is deeply devoted to her family, and is active in numerous civic and community activities.

Concerned currently with mathematical models and statistics to shape the future U.S. Army to perform its missions more effectively in a continually tumultuous worldwide environment—within severe limitations of reduced manpower and funding—Mrs. Cutchis has long been involved in military missilery. Primarily a top systems analyst, she also is experienced in design problems.

Despite the distinction of being a magna cum laude graduate from Hunter College in New York City, with a bachelor's degree in physics and mathematics, hunting for work in 1949 was difficult, she recalls.

When she succeeded in entering the guided missiles field as a computer analyst with Reeves Instrument Co., she considered herself "fortunate." Later she was with Goodyear Aircraft Co., in Akron, OH, and in 1951 began a 16-year association with the Johns Hopkins University Applied Physics Laboratory in Howard County, MD. One of her early assignments with the APL was senior mathematician with the Bumblebee Dynamics Group.

Selected by Dr. Milton Eisenhower, then president of the Johns Hopkins University, as the first woman to receive the prestigious JHU Parsons Fellowship, she spent a year of advanced study with Prof. G. S. Watson of the JHU Statistics Department. Her work was in the "general field of statistical theory for multidimensional sample spaces," with special attention to analysis of missiles and space vehicle guidance problems.

During the decade that has elapsed since her graduation from American University in Washington, DC, with a master's degree in mathematical statistics, Mrs. Cutchis, known to associates as Ange (for Angeliki), has not permitted her intense dedication to science to interfere with her devotion to her family and her numerous community affairs activities.

This intensity of concern with all aspects of a full life was recognized by Vice Admiral Bayne, commandant of the National War College, in a letter to the Secretary of the Army, commending her for having a "superb attitude . . . a human dynamo, always working, questioning, studying and thinking."

The letter was prompted, in part, by her achievement in preparing, as part of the course, a research paper titled "Mutual and Balanced Force Reductions: An Economic, Political and Military Collage."

The paper detailed possible options and consequences likely to follow U.S. and Soviet reduction of troop levels in Europe. It was selected as one of the top 15 in a class of 140 field grade officers and upper echelon civilians.

Pythagoras Cutchis, Ange's husband, was formerly a physicist with the JHU Applied Physics Laboratory until 1957 and later became a physicist with the Institute for Defense Analysis (IDA) in Washington, DC. They have a 15-year-old son, Protagoras, and 10-year-old daughter, Elektra.

ETL Mathematician 'Extremely Deserving of Recognition'

"Extremely deserving of recognition" is the way Mary Louise Powers was characterized by COL John E. Wagner, commander and director of the U.S. Army Engineer Topographic Laboratories, when he wrote regarding omission of her picture from our article on 1973 Army R&D Achievement Awards.

Mary Louise Powers

That omission was particularly undesirable to the staff of the *Army Research and Development Newsmagazine*—in view of our long-established policy of trying to give due recognition to the important role of many outstanding female scientists in Army materiel systems developments.

Mary Louise, a mathematical and computer analysis specialist, certainly qualifies high in that category, in view of her numerous contributions over the years. She was selected for a 1973 R&D Achievement Award on the basis of her work with Joseph F. Hannigan.

Their team effort was cited as "establishing the scientific basis" for a new technique of locating tactical positions such as artillery forward observers, artillery batteries, command posts, and automated remote sensors on the battlefield.

Omission explanation: Her picture was unavailable at press time.

Career Programs . . .

Cited for R&D Contributions

Army Reservist BG Willard Retires After 31 Years Service

BG Harry Lentz Willard, U.S. Army Reserve, associated with research and development activities since 1942, including 24 years as a Mobilization Designee in the Office of the Chief of Research and Development, HQ DA, has retired.

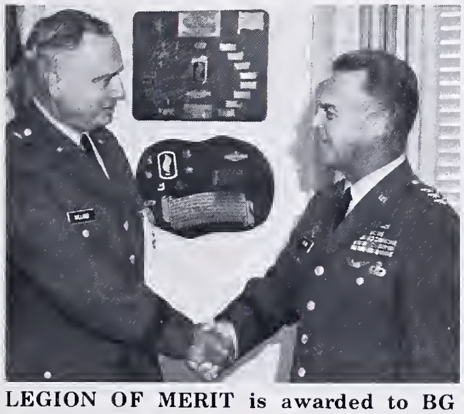
Succeeding him as one of two general officers assigned as MobDes assistants to Army Chief of R&D LTG John R. Deane Jr. is BG John H. Neiler, who has served with Willard for approximately two years. COL Gordon C. McKeague, a Military Intelligence specialist, has moved into the position vacated by BG Neiler, and will be considered for BG rank in 1974.

BG WILLARD's contributions to USAR and to Army R&D activities over nearly a third century of continuous service have been frequently recognized as exceptional. In his first assignment after being commissioned a first lieutenant in March 1942, he served with the War Department in Washington, DC, where his technical ability was used in the study of synthetic rubber and other synthetic-organic compounds development. He also functioned as liaison between WPB commodity specialists, the Army Technical Services, and industry.

Following an assignment with the U.S. Military Government in Germany, he reverted to Reserve status in June 1946 with rank of lieutenant colonel. He soon affiliated with the USAR R&D units and since 1963 has served as commander of what is now the 1672d MobDes Detachment in the Bronx, NY. He became MobDes assistant in OCRD in 1949.

In this capacity his duties encompassed a wide area of R&D activities, including:

- Monitoring and supervising review of the status of developments to determine actions required to accelerate key projects in event of hostilities.
- Reviewing and continually evaluating the over-all USAR program to ensure optimum utilization of facilities and personnel.
- Keeping the Chief of R&D advised of current developments in the various technologies of interest to the Army, and recommending particular lines of endeavor on which emphasis should be placed.



LEGION OF MERIT is awarded to BG Harry L. Willard by Chief of R&D LTG John R. Deane, in terminal recognition of 31 years service to Army R&D and to U.S. Army Reserve and MobDes programs.

- Monitoring activities in the civilian scientific and technological community that might have military applications; maintaining contacts with scientists in and out of government agencies, as well as with technical societies, universities, industrial laboratories, and various other research organizations in the interest of the Army.
- Evaluating facts for the Chief of R&D in management areas related to Army problems, inside and outside the Army.
- Representing the chief of R&D on Department of the Army boards, committees, and the Reserve Policy Council.

COL McKEAGUE set the stage for elevation to his new duties by serving in OCRD MobDes assignments in the Plans and Programs Directorate, and with the Assistant Chief of Staff for Intelligence. He also commanded the 408th Military Intelligence Detachment (SIRA) in Chicago, IL.

Entering military service as an enlisted man in January 1943, he served in the Asiatic-Pacific theater and was commissioned

COL Gordon C. McKeague

in November 1945. He is a graduate of the Military Intelligence Officer's Advanced Course, the Industrial College of the Armed Forces, the Command and General Staff College, and Army War College.

In civilian life, COL McKeague is the exploration operations manager for Amoco Production Co., a subsidiary of Standard Oil Co.-Indiana. He has a bachelor's degree in liberal arts (1950), a BS degree in biochemistry (1951) and a master's degree in business administration (1956), all earned at the University of Chicago. In 1969 he obtained an MS in geology from the University of Tulsa.

DoD Increases Management, Training Courses

Defense Management Education and Training Program courses at 18 primarily Service-operated schools are being increased to meet requirements that have exceeded their total capacity for DoD students by about 11,000 for FY 1974.

The U.S. Army Logistics Management Center (USALMC), for example, has compiled a list of recently announced eight resident courses currently offered to assist research, development, testing and engineering personnel in selecting courses that address concepts and skills in RDTE management. Numbered courses include:

Research and Development Management (5L-F3), a 2-week course that examines the organization and mission of the Army for research, development, test and evaluation of materiel; the characteristics and interrelationships of the functions involved; and the management systems and techniques employed. Emphasis is given to the materiel development process.

Test and Evaluation Management (8D-F30). This 9-day course examines the management considerations involved in the test and evaluation of Army materiel; the functions and responsibilities of the major commands and organizations involved; the management uses of statistics, risk analysis, and financial management; and problem solving in the T&E environment.

Operations Research/Systems Analysis, Executive (FA-F4). This 4-week course focuses on the characteristics, capabilities and limitations of operations research and systems analysis (OR/SA). Quantitative techniques leading to optimal decisions receive major emphasis. The impact of intangible factors in the optimal decision is examined. Applied statistics and modeling techniques also are emphasized.

The course culminates in a number of case studies that provide an opportunity for participants to examine critically proper and improper applications of OR/SA techniques.

Unnumbered courses include: *Decision Risk Analysis.* This 2-week course is devoted to the theory and application of qualitative and quantitative technology in conducting a risk analysis. Real-life case studies are used.

Cost Estimating for Engineers, a 2-week course, provides an overview of qualitative and quantitative techniques used in cost estimating and analysis. Methods of developing cost methods and procedures for evaluating uncertainties in cost estimates are discussed. Case problems tie together the ideas presented, using other methods of instruction, and place the student in an active role comparable to his actual work assignment.

Cost Analysis for Decision Making. This 4-week course emphasizes application of current cost analysis techniques and methodologies to selected case studies involving development of life-cycle costs. A review of quantitative techniques and principles appropriate to cost and economic analyses is provided.

Advanced Design Risk Analysis, a 2-week course, offers detailed information on the theory and application of the latest qualitative and quantitative techniques available for conducting a decision-risk analysis, through the use of real-life case studies.

Logistics Support Design Management. The 4-week course covers all aspects of life-cycle management with emphasis on a detailed evaluation of the engineering and logistics actions necessary to: field a new item or system; to support it throughout its life cycle; to determine the interrelationships of these support/engineering actions; to determine cause and effect factors relative to these actions; and to make management decisions.

The dates of the courses are determined each fiscal year by the USALMC, based on the over-all requirement input and further allocation of quotas for the courses. Prerequisites for each course can be found in the USALMC Course Catalog.

People in Perspective

Space Flight Safety . . .
BRL Employe Commended for Role

Edwin O'Leary

"Each member of the space team has an important role in achieving the Manned Flight Awareness objective of preventing errors and defects in space flight hardware and operations. The error prevented helps ensure a safe and successful mission and eliminates the cost of correction."

These are the words of CDR Alan Bean, a veteran of the Apollo program who commanded Skylab Project II, launched July 28 and successfully concluded Sept. 25.

Edwin O'Leary may never experi-

Edwin O'Leary may never experience the thrill of a crewman inside a space vehicle, but the crew members who have manned them, and who will continue to do so in the future, rely on O'Leary and others like him who are especially valuable members of the "team."

A technician with the Terminal Ballistics Laboratory (TBL) of the U.S. Army Ballistic Research Laboratories (BRL), Aberdeen Proving Ground, (APG), MD, O'Leary recently was cited for assistance during the launch of Skylab II, and is again fulfilling his role as part of the Skylab III team.

CDR Bean officially commended O'Leary for his work on the project and presented the National Aeronautics and Space Administration's (NASA) Astronaut's "Silver Snoopy" pin and citation.

O'Leary had been on a standby basis since the second day of the launch of Skylab II, when it was determined that a leak had developed in the control attitude motor. He remained on standby until the space vehicle was recovered safely by naval craft in the Pacific Ocean.

If it had become necessary to send a rescue vehicle to the aid of the spacecraft, O'Leary would have had to report to the Cape Kennedy site to take over operation of the sensors involved in the launch.

Continually alert to potential dangers of an explosion during takeoff, NASA officials required a record of the blastoff intensity for comparison with baseline data gathered at normal launches. This information is collected for action that has not been necessary to date—an accident that would create a need—to determine what caused the malfunction and to set up corrective procedures for later launches.

In satisfying that need—specifically, to measure and record the shock-wave of the blastoff as an abort-pad experiment—APG's TBL was pressed into service. Because of his participation in all former Apollo launches, and earlier work in the Gemini moon flight exploratory program, O'Leary was assigned to the project of setting up blast sensors in specified areas when propellants are aboard a rocket.

THEY MAN THE SKYLABS—Crew members of past, present and future Manned Orbital Scientific Space Station missions frame the Skylab space vehicle. Prime crews of Skylab I are shown at top; crew members of Skylab II, which successfully completed its mission Sept. 25, are at bottom left; and members of the crew of Skylab III, launched Nov. 16, are at bottom right.

Developed under the guidance of TBL physicist Ralph Reisler and Charles Hoover, a mechanical engineer, the sensors are about the size of a coffee can and contain tape recorders. The blast measurement of each Apollo launch was recorded in rising and falling intensity during the duration of each launch blast.

Following each launch, O'Leary brought the instruments back to TBL. Using a telecordex digital readout system, he transcribed the data recorded on the tapes and forwarded the information to the Space Center's safety office for analysis.

With the Apollo mission over, TBL and O'Leary continue to participate in the nation's space program. When Skylab III was launched into space Nov. 16, O'Leary was manning the sensor equipment, assisted by William T. Matthews, a TBL physical scientist.

During this 58-day mission, the temperature outside the Skylab varied from 200° F. to 200° below zero, but the crew experienced a shirt-sleeve environment inside the vehicle. Meanwhile, far below, in the Earth's environment, ranging from Cape Kennedy to APG, each member of the space team carried out his role in preventing and correcting causes of planning or mechanical errors.

ECOM Man 'Tunes Out' Electronics Interference

Marcel Racine

Frustration of interference to radio or television reception during climactic moments of a major sports event or a favorite program is an annoyance common in most American households, but few people worry about it like Marcel Racine of the Army Electronics Command.

That interference, in fact, constitutes his means of livelihood—as it has for 13 years in his employment as a frequency coordinator charged with the responsibility of minimizing the source of annoyance in ECOM laboratories.

Backed by more than 40 years experience in the electronics field, from the infancy of the industry, so to speak, he assigns operating frequencies to new equipment being developed and tested in the laboratories.

Explaining that his work requires continuing contact with several organizations at international, national, Army and command levels that control use of radio frequencies, he says the job calls for a broad knowledge of equipment capabilities and propagation.

Certain frequencies have been assigned to ECOM for testing purposes. When an engineer requests a frequency for research and development, Racine gets an allocation and assigns a specific frequency (or several frequencies) for the work. If a Federal Communications Commission frequency is needed, he gets it from an FCC Field Engineering Bureau.

Racine recalls that several years ago an aircraft interrogator radar was being tested at White Sands (NM) Missile Range. When the frequency authorization expired, the test supervisor was told to shut down until an extension was granted. Because a lengthy delay would be costly, he contacted Racine. Three hours later, he had an extension.

Another time, several radio devices operating at the low power of 50 watts were being used in conjunction with missile tests from Cape Kennedy. The FCC ordered all the stations closed because of interference with Canadian maritime operations. Racine recollects that "later we changed the frequency slightly and never heard another complaint."

Not all the problems come from official channels; many complaints come from area residents who feel that ECOM testing is causing TV interference.

In response to one complaint near an ECOM test site, Racine investigated and found that an electric fence at a nearby farm was causing the trouble. He suggested that the farmer install a special capacitor and the problem was solved.

In order to keep up with the latest developments, Racine is a member of several organizations of frequency coordinators. He recently joined a technical group under the International Telecommunications Union which is now reclassifying and developing new designations for electromagnetic emissions.

Conferences & Symposia . . .

OCRD Representative Heads Joint Service Engineering R&D Group

Chairmanship of the Joint Service Civil Engineering R&D Coordination Group, formed in February 1970 to achieve integrated planning and effort in engineering technology applying to the design, construction, operation and maintenance of military installations, changed at its 11th meeting.

Merrill Kreipke, acting chief of the Environmental Sciences Office, Office of the Chief of Research and Development, Department of the Army, succeeded LTC James M. MacKenzie, U.S. Marine Corps. The chairmanship is a rotational responsibility.

Dr. Valentine E. Zadnik, who works with Kreipke, is session coordinator of the group. The other Army member (two members represent each Service) is Robert F. Jackson, chief, Research Office, Office of the Chief of Engineers, Department of the Army.

Formation of the group was an outgrowth of recognition of the requirement for complementary pooling of Military Services engineering resources in development of certain objectives and programs, despite their special individual needs. The purpose is to minimize costly duplication of research, development, test and evaluation (RDTE) programs; also, to make maximum use of expertise in their laboratory facilities.

The group generally meets on a quarterly basis but may hold special meetings when the need arises. Two of the meetings are devoted primarily to review and coordination of the respective service programs for the forthcoming budget year. At other times the group centers its attention on special projects.

As an example, it was the JSCERDCG that promoted a series of coordination meetings between the Services on the subject of environmental quality at military installations. The result is a continuing beneficial dialogue at laboratory levels on this subject.

In another instance, the coordinating group convened an ad hoc working party to develop a soil stabilization coordinating paper. The paper discusses requirements, state-of-the-art deficiencies, operational and organizational concepts, conceptual approaches and categories of treatment.

While this document does not prevent any one of the Services from developing its own unique requirements in response to a particular problem area, it does provide a common basis of terminology and understanding that will facilitate coordination and provide for more effective programs.

The work of the ad hoc group on soil stabilization has now been completed and its findings are under review for approval.

A current ad hoc group area of special attention pertains to military shelters. MAJ John Bulov, Air Force Civil Engineering Center, is chairman. Working with him are staff members of the Army Construction Engineering Research Laboratory at Champaign, IL; Mobility Equipment Research and Development Center, Fort Belvoir, VA; the Natick (MA) Laboratories; the Naval Civil Engineering Laboratory, Fort Huenene, CA; and the U.S. Marine Corps Educational and Development Center, Quantico, VA.

Although this working group has been in existence only a short period of time, it has prepared a glossary of terms relating to mobile shelter systems and identified 10 areas of discussion to be treated in future meetings.

Chairman Kreipke said the Joint Services Civil Engineering R&D Coordinating Group must maintain a broadly based perspective to meet its responsibilities—a goal served partially by inviting outside speakers to present a timely subject of mutual interest at meetings.

During the past two years presentations have been made by COL P. W. A. Holdsworth, who was then serving as the British Liaison Officer (Engineering) at Fort Belvoir; William Warner, Department of Housing and Urban Development, who discussed programs within his agency and potential interfaces with the Military Departments; and Deputy Assistant Secretary of Defense for Environmental Quality John Busterud, whose topic was pollution abatement and control at military installations.

In this approach the group not only assures beneficially coordinated programs within the Department of Defense; it also takes into account areas of mutual interest with other U.S. Federal Departments and with foreign allies.

R&D MobDes Personnel Discuss 1973 Developments

"Research and Development Update—1973" was the theme of a symposium sponsored recently by the Chief of Research and Development, Department of the Army, for Mobilization Designation and Reserve R&D officers trained in science and engineering.

Army Chief of R&D LTG John R. Deane Jr. attended some of the sessions during the 2-week meeting hosted by the 627th Mobilization Designation Detachment in Scottsdale, AZ. Deputy Chief of R&D MG George Sammet Jr. presented the keynote address.

Other dignitaries who made presentations included Congressman James J. Rhodes of Arizona; MG Stewart C. Meyer, director, Research, Development and Engineering, Army Materiel Command; Dr. Jacob B. Gilstein, director, U.S. Army Advanced Ballistic Missile Defense Agency; and Dr. Ralph G. H. Siu, member, Army Scientific Advisory Panel.

More than 600 Mobilization Designees currently have research and development assignments. A larger number of positions not specifically identified as R&D also use MobDes scientists, engineers and technicians.

The purpose of the annual 2-week Reserve Seminars held in various regions is to provide an over-all picture of Army R&D, with emphasis on managerial aspects. Usually, high-ranking R&D leaders present reviews of the current status of major R&D activities.

The Scottsdale seminar, organized under the direction of COL Roy E. Coulson as commander of the 627th MobDes Detachment, opened with an abridged version of the Life Cycle Management Models to which other topics were referred.

Topics included Requirements Generation; R&D Management; Reliability, Availability and maintainability (RAM); Human Factors in R&D; "The Big Five" materiel development and acquisition projects; and Congressional Attitudes Toward Department of Defense R&D Expenditures.

Roughly 50 percent of the program consisted of field trips and presentations by leaders of Arizona-based activities. Visited were Fort Huachuca, AZ, HQ of the Army Communications Command; Motorola Government Electronics Division; Air Research, Inc., Phoenix, AZ; Barrow Neurological Institute, and the Heart Institute, St. Joseph Hospital; and Dynamic Science, Inc., Phoenix. Yuma (AZ) Proving Ground and Fort Huachuca leaders presented briefings at Scottsdale.

A similar 2-week seminar is being planned next summer in the Minneapolis-St. Paul, MN, area with the 575th MobDes arranging and hosting the meeting.

Solid Mechanics Symposium Abstracts Criteria Outlined

Theoretical and experimental papers keyed to "The Role of Mechanics in Design—Structural Joints" are being solicited for the U.S. Army Symposium on Solid Mechanics, scheduled in South Yarmouth, Cape Cod, MA, Sept. 10–12, 1974.

Acceptable papers must originate from in-house or contract researchers or designers of the U.S. Army, Navy, Air Force, National Aeronautical and Space Administration or the Nuclear Defense Agency. Papers must be unclassified and extended abstracts (about 500 words) with illustrations attached as appropriate, are required prior to Jan. 1.

Selection criteria for papers will include originality, theme relevance, soundness of approach and clarity of ideas. Authors selected on the basis of their abstracts must submit manuscripts for review by May 1.

Papers are sought within the general area of joints in structures and in advanced materials, including composites, with emphasis on the application of mechanics for the solution of design and engineering problems.

Typical theme topics include: stress analysis of joint configurations (e.g., pin, threaded, lap, hinges, bonded or adhesive, weld, interference fits), stress analysis of material discontinuities (e.g., multimaterial joints), joint modeling techniques, functional considerations (e.g., energy absorption, damping, fail-safe, load transfer, transmission/attenuation) and environmental effects (e.g., thermal, blast, radiation).

This will be the fourth biennial symposia sponsored by the Technical Working Group for Mechanics of Materials, an element of the Army Materiel Command Materials Advisory Group. The objective of the unclassified meeting (attendance open to U.S. citizens) is to improve effectiveness of mechanics research for the design of advanced military systems.

Technical sessions will include a "Work in Progress" presentation and discussion on ongoing research. Published proceedings will be available at the symposium.

Additional information may be obtained by an inquiry to: Army Materials and Mechanics Research Center, AMXMR-T (R. Morrissey), Watertown, MA 02172, or telephone (617) 926-1900, Ext. 253, or Autovon 684-8253.

Personnel Actions...

Air Force LTG Johnson Named DNA Director

LTG Warren D. Johnson

LTG Warren D. Johnson, who became the new director of the Defense Nuclear Agency following the recent retirement of LTG Carroll H. Dunn, began his military career as an Army enlisted man and was commissioned in November 1942 as an Army Officer Candidate School graduate.

Until he took over as DNA's deputy director for Operations and Administration in May 1973, LTG Johnson was chief of staff, U.S. Air Force Strategic Air Command. In 1969 he was assigned as commander, U.S. Air Forces, Azores, and commander, 1605th Air Base Wing, Lajes Field, Azores.

Other key Air Force assignments have included director, Personnel Resources and Distribution, USAF Military Personnel Center; commander, 57th Air Division: vice commander and later commander, 380th Strategic Aerospace Wing, SAC; and deputy director for Personnel, HQ, 8th Air Force.

LTG Johnson attended Oklahoma City University, graduated from Army Officer Candidate School in November 1942, and was assigned to the 9th Armored Division at Fort Riley, KS. He completed advanced pilot training and B-17 transition training in 1944 and was assigned to Japan with the Far East Air Forces.

His military honors include the Legion of Merit with two Oak Leaf Clusters (OLC), Joint Service Commendation Medal, and the Air Force Commendation Medal with OLC.

Sammet Joins AMC, Guthrie to CINCPAC

MG George Sammet Jr.

MG George Sammet Jr., Army Deputy Chief of R&D since Jan. 4, 1971, assumed new duties as deputy commander, Materiel Acquisition, U.S. Army Materiel Command, effective Oct. 23, succeeding MG John R. Guthrie, now deputy chief of staff under the Commander in Chief, Pacific, HI.

A 1940 graduate of the University of Illinois, MG Sammet has a master's degree from George Washington University and has completed the Management School for Executives, University of Pittsburgh's Graduate School of Business, and the National War College.

MG Sammet entered the R&D field in 1959 with assignment to the Office of the Army Chief of R&D. He served successively in the International Division, Plans and Programs Division, Combat Materiel Division and later as deputy director, Developments.

Other key OCRD assignments have included deputy director, Missiles and Space; executive officer; and, prior to his appointment as deputy CRD, director of Plans and Programs.

Among his military awards and decorations are the Legion of Merit with two Oak Leaf Clusters (OLC), Bronze Star Medal (valor), Air Medal, Army Commendation Medal with OLC and Purple Heart.

MG John R. Guthrie

MG Guthrie was assigned to the Army Materiel Command in 1968, serving initially as deputy director of Development and Engineering and later as director of Research, Development and Engineering. He was assigned as assistant division commander, Maneuver and Support, 2d Infantry Division, Korea in 1967.

In 1966 he was named director of Developments, Office, Chief of R&D, HQ DA, following duty in 1965 with the Requirements and Development Division, Office of the Joint Chiefs of Staff. He also has served as commander, 602d Field Artillery Battalion, Fort Sill, OK.

MG Guthrie has an AB degree in history from Princeton University and is a graduate of the Army Command and General Staff College and the National War College.

Included among his military honors are the Legion of Merit with two Oak Leaf Clusters (OLC), Bronze Star Medal with two OLC, Joint Service Commendation Medal, & Army Commendation Medal.

Cooksey Assigned Deputy Chief of Army R&D

MG Howard H. Cooksey

MG Howard H. Cooksey, former deputy commander, U.S. Support Activities Group, Thailand, has succeeded MG George Sammet Jr. as deputy chief of Research and Development, HQ DA.

MG Cooksey served briefly in 1973 as acting chief of staff, U.S. Military Assistance Command, Vietnam after 1972–73 service as commander, 1st Regional Assistance Command and senior advisor, U.S. Military Assistance Command, Vietnam.

Other key assignments have included commander, U.S. Army Training Center, Fort Dix, NJ; commander, 1st Brigade, 2d Infantry Division, U.S. Army, Pacific-Korea; and deputy chief (later chief), Combat Materiel Division, and later executive officer, Office, Chief of R&D, DA.

MG Cooksey has a BS degree in business administration from Virginia Polytechnic Institute and an MA degree in international affairs from George Washington University. His military schooling includes the Armored School, Army Command and General Staff College, Armed Forces Staff College, and the National War College.

Among his military awards and decorations are the Distinguished Service Medal, Silver Star, Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal with "V" device and two OLC, Air Medal (15 awards), Army Commendation Medal with two OLC and the Purple Heart.

Rachmeler Directs Industrial Preparedness

BG Louis Rachmeler

BG Louis Rachmeler, former deputy commander, U.S. Army Missile Command, has assumed new duties as director of Industrial Preparedness and Munitions Production, Office, Assistant Secretary of Defense (Installations and Logistics).

Prior to assignment to Redstone Arsenal, AL, HQ U.S. Army Missile Command in 1970, he served an 18-month tour with the 1st Logistical Command, Vietnam and a 6-month assignment on the Army Staff, Washington, DC. He has also served in Germany and France.

During 1958 he was an ordnance officer for nuclear tests in the Marshall Islands and later a nuclear weapons instructor at the Army Command and General Staff College. He has also served with the Special Warfare Division, Office of the Chief of R&D, HQ DA.

BG Rachmeler began his military career as an enlisted man in 1943 after attending City College of New York.

A 1947 graduate of the U.S. Military Academy, West Point, NY, he has a master's degree in electrical engineering from Stanford University. He has completed the Army Command and General Staff College and the Army War College.

Included among his military honors are the Legion of Merit with three Oak Leaf Clusters (OLC), Air Medal and Army Commendation Medal with OLC.

Adams Becomes USACSC Deputy Commander

Deputy commander, U.S. Army Computer Systems Command, Fort Belvoir, VA, is the new assignment of BG Walter Edwin Adams, former commander, 3d Brigade, 1st Armored Division, U.S. Army, Europe.

A graduate of the U.S. Military Academy, BG Adams also earned a master's degree in international affairs from George Washington University. His military schooling includes the Army Command and General Staff College and the Armed Forces Staff College.

Key assignments have included special assistant to the Director of Management Information Systems, Office, Assistant Vice Chief of Staff; and deputy commander, 3d Brigade, 25th Infantry Division, U.S. Army Pacific Vietnam.

Metzger Commands Infectious Disease Institute

COL Joseph F. Metzger

Commander, U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD, is the new title of COL Joseph F. Metzger, who had served as the institute's chief of pathology since 1968.

COL Metzger earned his MD degree from George Washington University in 1950. He then entered the Army and served a year internship and four years residency at Walter Reed General Hospital, Washington, DC.

Included among his previous tours of duty are commander, 406th Medical Laboratory, Japan; chief, Bacteriology and Immunology Branch, Geographic Pathology Division, Armed Forces Institute of Pathology; and tissue pathologist and chief of Laboratory Services, Kyukus Army Hospital, Okinawa.

Certified by the American Board of Pathology, COL Metzger was awarded an "A" prefix for pathology by the U.S. Army Surgeon General and a research fellowship from Louisiana State University. His military honors include the Legion of Merit and the Army Commendation Medal.

Reilly Commands/Directs Engineer Power Group

COL William F. Reilly

COL William F. Reilly recently assumed new duties as commander and director, U.S. Army Engineer Power Group, Fort Belvoir, VA, succeeding COL Harvey L. Arnold Jr., now assigned to the Army War College.

A 1952 graduate of the U.S. Military Academy, COL Reilly has master's degrees in nuclear engineering from Massachusetts Institute of Technology and from George Washington University in management science operations research.

During 1971-72 he served as chief, Programs Branch, Office of the Chief of R&D, HQ DA. This followed 1969-71 duty with the Engineer Strategic Studies Group. He was commander, 326th Engineer Battalion, 101st Airborne Division, Fort Campbell, KY, and Vietnam in 1967-68.

A graduate of the Industrial College of the Armed Forces, COL Reilly is a recipient of the Legion of Merit, Bronze Star Medal with Oak Leaf Cluster (OLC), Meritorious Service Medal with OLC, Air Medal, Army Commendation Medal w/3 OLC and the Purple Heart.

ECOM Selects Hand as Avionics Lab Director

COL Lee M. Hand

COL Lee M. Hand, a recent graduate of the Industrial College of the Armed Forces, has been named director of the Avionics Laboratory, U.S. Army Electronics Command, Ft. Monmouth, NJ.

A 22-year Army veteran, COL Hand was commissioned in the Signal Corps in 1952. His most recent assignment was with the Office of the Chief of Staff for Force Development.

Other key assignments have included the 2d Armored Division, Germany; head of the Signal Met Team, Greenland; and two tours in Vietnam with the 117th Assault Helicopter Company and later with the 1st Aviation Brigade.

COL Hand has done graduate work in meteorology at the University of Utah and is a recipient of the Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal, Air Medal with OLC, Joint Service Commendation Medal, Army Commendation Medal with OLC, and Purple Heart.

Philipp Directs TACOM RD&E Directorate

LTC Ronald E. Philipp

LTC Ronald E. Philipp is the new director of the Research, Development and Engineering Directorate, U.S. Army Tank-Automotive Command (TACOM), Warren, MI, following the recent retirement of COL Louis F. Felder.

LTC Philipp has served at the U.S. Army Ordnance School in the Office of the Chief of R&D, HQ DA, and with the U.S. Army Control and Disarmament Agency, Washington, DC.

His academic credentials include a BS degree from Lafayette College, an MS degree from Lehigh University, and a PhD from Columbia University, all in mechanical engineering. He has also attended the Army Command and General Staff College and the National War College.

Among his military honors are the Legion of Merit, Bronze Star Medal with Oak Leaf Cluster (OLC), Meritorious Service Medal with OLC, Air Medal with three OLC, and the Army Commendation Medal with two OLC.

MRC Lists Research Staff Members for 1973-74.

Thirty-seven prominent mathematicians, five from foreign countries, have been selected by the Mathematics Research Center (MRC) to serve as research staff members for the 1973-74 academic year.

Located on the University of Wisconsin campus, the MRC is a contract agency performing research in applied mathematics related to military needs. Five members serve on the permanent MRC staff. The remaining members, on sabbatical leave from educational institutions, pool their knowledge to keep the MRC informed of the latest trends in mathematics.

Permanent staff researchers are *Carl de Boor,* specialist in approximation theory and numercial analysis; *Te Chiang Hu*, combinatorial mathematics and discrete optimization; *Herman F. Karreman*, stochastic processes; *Ben Noble*, integral equations and variational methods; and *Louis B. Rall*, numerical analysis, integral equations and functional analysis.

Other research members, their academic affiliations and fields of mathematical specialization include acting director *Creighton R. Buck*, University of Wisconsin (UW), analysis and approximation theory; *George E. P. Box*, UW, statistical design and analysis; *Richard C. Brown*, MRC, boundary value problems and stability; *K. W. Chang*, University of Calgary, Canada, ordinary differential equations; *Gheorge A. Coman*, Babes-Bolyai University, Romania, spline functions; and

Charles C. Conley, UW, celestial mechanics and differential equations; *James T. Day*, Pennsylvania State University, quadrature formulas; *Richard H. Day*, UW, mathematical economics; *Norman R. Draper*, UW, statistics; *Brud E. Easton*, MRC, mathematical economic theory; *Millard W. Johnson*, UW, rheology; *Heinz-Otto Kreiss*, University of Uppsala, Sweden, numerical analysis; *Robert A. LaBudde*, MRC, computing techniques in physical chemistry; and

Melanie L. Lenard, University of Toledo, mathematical programing; *Arthur S. Lodge,* UW, theology; *Raphael Loewy,* MRC, matrix theory and mathematical programing; *Robert R. Meyer,* Nonlinear programing and discrete optimization; *David R. Musser,* UW, and University of Texas-Austin, symbol manipulation; *Seymour V. Parter*, UW, numerical methods for partial differential equations; *Narahari U. Prabhu*, Cornell University, queing theory; and

Stephen M. Robinson, MRC, optimization and multivalued functions; *Dale F. Rudd*, UW, process engineering; *David A. Sanchez*, University of California-Los Angeles, calculus of variations, optimal control, and ordinary differential equations; and

Godela Scherer-Gruber, University of Uppsala, Sweden, numerical analysis; *Isaac J. Schoenberg*, MRC, analytical approximation theory, distance geometry; *Larry L. Schumaker*, University of Texas-Austin, approximation theory; *David A. Spence*, University of Oxford, England, applied analysis, hydrodynamics; and

Ram P. Strivastav, State University of New York-Stony Brook, integral equations, elasticity; *Warren E. Stewart*, UW, fluid mechanics, reactor design; *Leslie E. Trotter Jr.*, MRC, discrete optimization; *Michael J. Yohe*, MRC, computer programing, topology; and *Laurence C. Young*, UW, convex sets and inequalities, stochastic processes, calculus of variations, optimal control, and functionl analysis.

Awards . . .

2 ETL Personnel Win CO's Awards

USAETL Commander COL John E. Wagner presents Scientific and Technological Award to Wesley H. Shepherd (center) and Leadership Award to Melvin Crowell at Engineer 'Topo' Labs.

Commanding Officer's Awards for Scientific and Technological Achievement and for Leadership at the U.S. Army Engineer Topographic Laboratories (USAETL), Fort Belvoir, VA, recently honored Wesley H. Shepherd and Melvin Crowell.

USAETL Commander COL John E. Wagner made the fifth annual presentations during ceremonies at which BG Wayne S. Nichols, director of Military Engineering and Topography, Office of the Chief of Engineers, commended the laboratories for mapping and surveying research and development achievements.

Shepherd, the only nominee for the Scientific and Technological Achievement Award, was cited for design and development of hardware and software for Digital Input/Output Display Equipment, a major component of the semiautomated cartography system.

Developmental work, the citation states, required a knowledge of diverse disciplines, including cartography, computer programing, electronics, and systems engineering. He is credited with transforming basic mathematical concepts into operating programs to prove the feasibility of an automatic editing device.

Shepherd earned a BS degree in civil engineering from Washington and Lee University in 1963 and has been at USAETL since 1964.

Crowell, one of two nominees for the Leadership Award, was selected for outstanding leadership in accomplishment of an expedited development program directed to equipping field Army units with a capability of applying photogrammetric techniques toward solution of tactical positioning problems.

Acceptance of the Analytic Photogrammetric Positioning System within the Department of Defense for a wide variety of applications ranges from the provision of general survey support to direct support of major weapons systems.

Credited with achieving teamwork that effectively pooled technical expertise and resources to accomplish the assigned task, Crowell earned a BS degree at the University of Illinois in 1951 and entered Civil Service the same year. He has been employed at USAETL since 1958.

EXCEPTIONAL CIVILIAN SERVICE. *Dr. Charles M. Johnson*, former deputy system manager for Science and Technology, U.S. Army Safeguard Systems Command, recently received the Decoration for Exceptional Civilian Service (DECS).

Dr. Johnson was recognized for 1967–73 contributions in establishing the Army's capability to deploy the first U.S. ballistic missile defense system. He was cited specifically for management and technical direction of the Nike-X, Sentinel and Safeguard systems.

MERITORIOUS CIVILIAN SERVICE. *Charles Riley, Melvin Crisco* and *Hugh Greene*, all employes of the Army Missile Research, Development and Engineering Laboratory, Redstone (AL) Arsenal, received the Meritorious Civilian Service Medal (MCSM), the Army's second highest award for civilian employes.

Riley was cited for establishing a prototype fabrication facility. Crisco was recognized for planning initial scheduling and productive operation of the fabrication facility. Greene earned his award for analysis and simulation of electromagnetic pulses on missile system performance.

Dr. Charles M. Johnson

DISTINGUISHED SERVICE MEDAL. *BG George M. Snead Jr.*, former deputy commander, U.S. Army Strategic Communications Command (STRATCOM) (now U.S. Army Communications Command (USACC)), received the Distinguished Service Medal at his retirement ceremonies, capping 30 years of military service.

Presented by MG Jack A. Albright, commander, STRATCOM (USACC), the award is the Army's highest noncombat decoration. BG Snead was praised for performance of duties from 1964–73.

LEGION OF MERIT. *COL John C. Littlejohn* was awarded the Legion of Merit (LM) for outstanding service as director of the Air Defense Materiel Testing Directorate, HQ U.S. Army Test and Evaluation Command from 1969–73.

LTC William H. Doolittle, MC, received the LM at his recent retirement ceremonies following 24 years of active military service. He was cited for outstanding and meritorious service as director of the Arctic Medical Research Laboratory in Alaska.

MERITORIOUS SERVICE MEDAL. *COL Delores L. Evanson*, AMSC, physical therapy consultant, U.S. Army Health Services Command, was awarded a first Oak Leaf Cluster to the Meritorious Service Medal for duty at Walter Reed Army Medical Center.

MG Spurgeon H. Neel, commander, Army Health Services Command, presented the award and citation to COL Evanson for "outstanding leadership as an administrator, clinician and educator."

ARMY COMMENDATION MEDAL. *CPT Samuel C. Shiflett*, MSC, was presented an Army Commendation Medal for 1972–73 service as an R&D coordinator with the U.S. Army Institute for the Behavioral and Social Sciences, Office of the Chief of R&D.

He was cited specifically for skillful advance planning and effective coordination of field research on an Army-wide basis; also, for developing and managing numerous research activities.

ARMY SUPERIOR AWARD WINNER at the 1973 International Science and Engineering Fair (ISEF), John C. MacGuire (right), holds model section of an acoustical building under development at the Ames Directorate, U.S. Army Air Mobility R&D Laboratory (AMRDL), Moffett Field, CA. Dr. Richard M. Carlson (left), chief of AMRDL's Advanced Systems Research Office, was instrumental in placing John with the Ames Directorate on a summer research project as part of his award. MacGuire also was a guest of NASA at the July launch of Project Skylab and will attend the Japan Student Science Awards in Tokyo in January 1974. Dr. Irving C. Statler (center), director of the Ames Directorate, arranged and supervised his research. MacGuire is looking forward to entering either the University of Pennsylvania or the Massachusetts Institute of Technology when he completes high school in June 1974. (For further information on ISEF winners, see July-August 1973 issue of this *Army R&D Newsmagazine.)*

AMMRC Development Improves Coated Refractory Metal Alloys

By Dr. Robert D. French and Milton Levy

In response to engineering demands for materials with useful strengths and service lives at temperatures above 2000° F., refractory materials are being developed at the U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA.

An area of prime interest is the development of coated columbium alloys for use in oxidizing atmospheres, with the most probable application in gas-turbine engines.

Columbium alloys will require protective coatings in service, it is now generally agreed, but it remains important to understand the kinetics of base metal oxidation. Since defective or damaged coatings may not be avoidable, oxidation behavior of both uncoated and coated alloys has been investigated.

AMMRC investigations by Levy, Joseph J. Falco and Robert Herring have characterized oxidation in terms of rate laws and reaction products. Levy and Falco have also demonstrated that a simple thermal treatment, after the coating is applied, will eliminate the catastrophic oxidation known as "pesting." This is common to coated refractory metals exposed to temperatures between 1400° F. and 1600° F.

Oxidation of columbium alloys, similar to that of pure columbium, proceeds through several linear and parabolic stages. Generally, for conventional applications, attention is focused on transitions from parabolic to linear behavior, where the initially protective oxide layer loses its protective ability and breakaway oxidation occurs. AMMRC researchers have examined reaction rates of two types of columbium alloys, one solution-hardened, the other dispersion-strengthened.

Although sufficient evidence does not exist for generalizing the findings of this study for either type of alloy, significant differences in oxidation behavior have been noted. Oxidation of the dispersion-strengthened alloy changed from linear to parabolic between 1200° F. and 1400° F.; oxidation of the solution-hardened alloy remained linear between 1400° F. and 1600° F.

The fact that the dispersion-strengthened alloy demonstrated greater oxidation resistance between 1400° F. and 1600° F., is significant—particularly for thin-section components, when the engineering application requires exposure over this temperature range.

Between 1800° F. and 2000° F., weight gains of the uncoated alloys decreased with increasing temperature for equal exposure times. The predominent oxide was identified as Cb_2O_5. The temperature range within which the anomalous change in oxidation was found is coincident with the range where Cb_2O_5 is structurally transformed.

Unfortunately, this apparent structural advantage cannot be used effectively since other reaction products begin to appear. As a result, above 2200° F., breakaway oxidation occurs after a few minutes—sooner for the solution-hardened alloy than for the dispersion-strengthened alloy. Both alloys have weight gains in excess of 20 mg/cm^2 in one hour at temperatures above 2000° F.

An acceptable value for practical applications would be 15 mg/cm^2 for 200 hours or 25 mg/cm^2 for 1,000 hours. Since neither alloy would have adequate oxidation resistance at these temperatures, protective coatings would be required.

Similar static oxidation tests were conducted on coated columbium alloys. These coatings were complex silicides of the duplex type, having a dense inner diffusion layer adjacent to the base metal alloy and an outer porous reservoir layer that is depleted through oxidation.

Between 1400° F. and 1600° F., and within relatively short-exposure times, enhanced inter-crystalline oxidation of the silicide coating occurs. This results in a voluminous oxide-reaction product, that is, the "pesting" mentioned earlier. In a dynamic environment, this reaction product would be rapidly swept away and continuous exposure would be catastrophic to the coated alloy.

Above 1600° F. and through 2500° F., the silicide coatings provided complete protection in a static environment for 1,000 hours. Above 1600° F. the silicides react with oxygen to produce a glassy phase at the outer surface which acts as a diffusion barrier

Results of this experimentation suggested that exposure to an oxidizing environment for a short time at temperatures above 1600° F. would produce a protective barrier to eliminate pesting. To test this hypothesis, coated samples were oxidized for one hour at 2400° F. before exposing them to temperatures between 1400° F. and 1600° F. As anticipated, pesting was completely eliminated, as shown in Figure 1.

This discovery has since been adopted in at least one commercial coating procedure and is applicable to silicide coatings on other refractory metals. Technical details of the oxidation kinetics of both uncoated and coated alloys were presented at the Dec. 5–7, 1972, Tri-Service Corrosion Conference hosted by the AMMRC in Houston, TX.

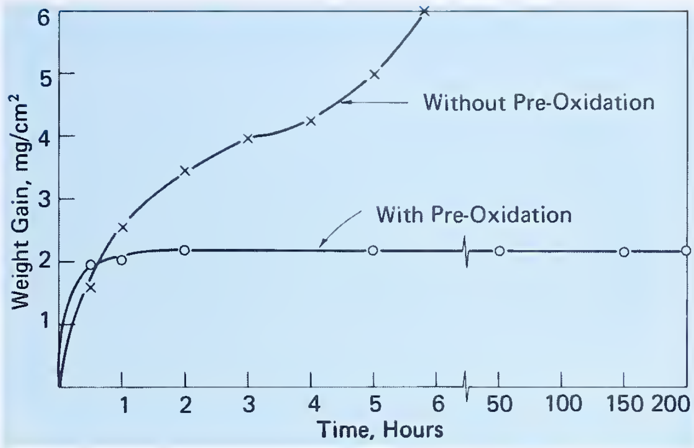


Fig. 1. Effect of preventive treatment on oxidation of a silicide-coated refractory metal alloy at 1400° F.

Further development of the silicide coatings is possible through the introduction of different elements to the glassy phase for the purpose of lowering the viscosity. This could lower the processing temperature and provide a greater tolerance for plastic deformation of the coated alloy. Development of the preoxidation thermal treatment, by itself, has overcome one of the outstanding problems facing the possible use of coated refractory metal alloys.

One of the most important foreseeable applications of refractory metal alloys will be in gas-turbine engines. Specific fuel consumption and specific horsepower depend on the engine efficiency, which is directly related to the gas temperature leaving the combustor and entering the gas generator stage.

Metal alloys commonly used at this point in the engine must be cooled to a temperature where they have useful strength and resistance to time-dependent deformation. Cooling air for this purpose is drawn from the high-pressure end of the compressor, the air is lost to power generation, and the engine efficiency is lowered.

Coated refractory metal alloys may be used for the highest temperature components with little or no cooling air required. This would lower specific fuel consumption and raise specific horsepower; it would also remove the currently accepted risk that a blocked cooling passage would be catastrophic to the metal alloy.

Development of refractory alloy/coating systems is continuing at the AMMRC. Current engineering trends indicate that the investment is justified by the potential for a substantially larger return.

DR. ROBERT D. FRENCH joined the scientific staff of AMMRC as a research metallurgist in 1970 and was appointed group leader for physical metallurgy in 1971. He served on active duty as a captain with the Army Corps of Engineers from 1967 through 1969.

A graduate of Northeastern University (BS, 1962; MS, 1964), he received his doctorate from Brown University in 1967.

MILTON LEVY has been a supervisory chemist with AMMRC since 1958, following employment as a physical chemist at the Ballistic Research Laboratories and the Coating and Chemical Laboratory at Aberdeen Proving Ground, MD.

Presently serving as a chemical metallurgy group leader with the Metals Research Division, Levy holds a BS degree from Boston University and has done graduate work in chemistry and physics.

Dr. Robert D. French

Milton Levy

FORT GREELY, ALASKA, home of the U.S. Army Arctic Test Center, has the distinction of presenting one of the most severe winter climates in the world—a rugged, gruelling environment that subjects men and materiel to "the moment of truth" exposure with respect to combat readiness for operations in the Far North. In summer, however, Bolio Lake near Fort Greely is virtually a recreational and sportsman's paradise—attractive also to personnel of the U.S. Army, Alaska, 172d Arctic Light Infantry Brigade, headquartered at Fort Richardson. **(See feature article, page 16.)**